# Radiological Health Data

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APRIL 1961

Quarterly Report

U.S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE

Public Health Service

In August 1959, the President directed the Secretary of Health, Education, and Welfare to intensify departmental activities in the field of radiological health. The Department was assigned responsibility within the Executive Branch for the collation, analysis, and interpretation of data on environmental radiation levels. The Department delegated this responsibility to the Division of Radiological Health, Public Health Service.

*Radiological Health Data* is published by the Public Health Service on a monthly basis. Data are provided to the Division of Radiological Health by other Federal agencies, State health departments, and foreign governments. Except where material is directly quoted or otherwise credited, summaries and abstracts are prepared by the staff of the Data Collation and Analysis Unit, Division of Radiological Health. The reports are reviewed by a Board of Editorial Advisers with representatives from the following Federal agencies:

Department of Health, Education, and Welfare
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Department of Defense
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# RADIOLOGICAL HEALTH DATA

QUARTERLY REPORT APRIL 1961

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U.S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE

Public Health Service • Division of Radiological Health

FIGURE 1.—RADIATION SURVEILLANCE NETWORK SAMPLING STATIONS

TABLE 1.—RADIOACTIVITY OF PARTICULATES IN AIR—GROSS BETA DETERMINATIONS

*Public Health Service Radiation Surveillance Network, November 1960*

| Station location | Number samples | Maximum ($\mu\mu c/m^3$) | Minimum ($\mu\mu c/m^3$) | Weighted average ($\mu\mu c/m^3$) | Station location | Number samples | Maximum ($\mu\mu c/m^3$) | Minimum ($\mu\mu c/m^3$) | Weighted average ($\mu\mu c/m^3$) |
|---|---|---|---|---|---|---|---|---|---|
| Anchorage, Alaska | 20 | 0.10 | <0.10 | <0.10 | Pascagoula, Miss | 16 | .25 | <.10 | <.13 |
| Fairbanks, Alaska | 20 | <.10 | <.10 | <.10 | Jefferson, Mo | 18 | <.10 | <.10 | <.10 |
| Juneau, Alaska | 19 | <.10 | <.10 | <.10 | Helena, Mont | 18 | <.10 | <.10 | <.10 |
| Phoenix, Ariz | 8 | .16 | <.10 | .11 | Trenton, N.J | 7 | .18 | <.10 | <.11 |
| Little Rock, Ark | 15 | <.10 | <.10 | <.10 | Santa Fe, N. Mex | 18 | <.10 | <.10 | <.10 |
| Berkeley, Calif | 19 | <.10 | <.10 | <.10 | Albany, N.Y | 24 | .12 | <.10 | <.10 |
| Los Angeles, Calif | 19 | .13 | <.10 | <.10 | Gastonia, N.C | 21 | .24 | <.10 | <.11 |
| Denver, Colo | 14 | .15 | <.10 | <.10 | Cincinnati, Ohio | 20 | .10 | .00 | .04 |
| Hartford, Conn | 28 | .11 | <.10 | <.10 | Oklahoma City, Okla | 16 | .10 | <.10 | <.10 |
| District of Columbia | 20 | <.10 | <.10 | <.10 | Ponca City, Okla | 30 | <.10 | <.10 | <.10 |
| Jacksonville, Fla | 17 | <.10 | <.10 | <.10 | Portland, Oreg | 19 | .22 | <.10 | <.11 |
| Atlanta, Ga | 17 | .17 | .02 | .06 | Harrisburg, Pa | 16 | .12 | <.10 | <.10 |
| Honolulu, Hawaii | 19 | <.10 | <.10 | <.10 | Providence, R.I | 18 | <.10 | <.10 | <.10 |
| Boise, Idaho | 5 | <.10 | <.10 | <.10 | Columbia, S.C | 7 | .11 | <.10 | <.10 |
| Springfield, Ill | 12 | <.10 | <.10 | <.10 | Pierre, S. Dak | 5 | <.10 | <.10 | <.10 |
| Indianapolis, Ind | 30 | <.10 | <.10 | <.10 | Austin, Tex | 20 | <.10 | <.10 | <.10 |
| Iowa City, Iowa | 20 | .13 | <.10 | <.10 | El Paso, Tex | 17 | .22 | <.10 | <.14 |
| Topeka, Kans | (1) | (1) | (1) | (1) | Salt Lake City, Utah | 29 | .12 | <.10 | <.10 |
| New Orleans, La | 6 | <.10 | <.10 | <.10 | Richmond, Va | 18 | <.10 | <.10 | <.10 |
| Baltimore, Md | 18 | .12 | <.10 | <.10 | Seattle, Wash | 19 | <.10 | <.10 | <.10 |
| Lawrence, Mass | 19 | <.10 | <.10 | <.10 | Cheyenne, Wyo | 8 | <.10 | <.10 | <.10 |
| Lansing, Mich | 30 | .10 | <.10 | <.10 | Madison, Wis | 18 | <.10 | <.10 | <.10 |
| Minneapolis, Minn | 8 | <.10 | <.10 | <.10 | | | | | |

[1] No samples received.

TABLE 2.—RADON AND THORON MEASUREMENTS

*Public Health Service Radiation Surveillance Network Station at Cincinnati, Ohio, November 1960*

| Date | Continuous sample collection | | | Radon [a] a.m. ($\mu\mu c/m^3$) | Radon [b] p.m. ($\mu\mu c/m^3$) | Thoron [c] ($\mu\mu c/m^3$) | Beta [d] activity ($\mu\mu c/m^3$) | Date | Continuous sample collection | | | Radon [a] a.m. ($\mu\mu c/m^3$) | Radon [b] p.m. ($\mu\mu c/m^3$) | Thoron [c] ($\mu\mu c/m^3$) | Beta [d] activity ($\mu\mu c/m^3$) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Sample change time | Sample period (hours) | Volume ($m^3$) | | | | | | Sample change time | Sample period (hours) | Volume ($m^3$) | | | | |
| 1 | 0815 | 24.1 | 29.8 | 220 | 140 | 1.2 | 0.01 | 16 | 0820 | 24.0 | 28.9 | 90 | 220 | 1.4 | .09 |
| 2 | 0810 | 23.9 | 28.7 | 260 | 160 | 2.2 | .02 | 17 | 0821 | 23.9 | 29.4 | 360 | 140 | 2.4 | .05 |
| 3 | 0828 | 24.3 | 29.4 | 90 | 70 | 1.6 | .1 | 18 | 0816 | 23.9 | 28.5 | 480 | 200 | 4.5 | .02 |
| 4 | 0830 | 24.0 | 29.5 | 420 | 190 | 5.0 | .02 | 21 | 0820 | 72.0 | 83.4 | 790 | 280 | 7.4 | .04 |
| 7 | 0823 | 71.8 | 88.3 | 200 | 70 | 2.6 | .02 | 22 | 0820 | 23.9 | 27.8 | 970 | 210 | 6.7 | .09 |
| 8 | 0815 | 23.8 | 29.4 | 280 | 150 | 4.4 | .0 | 23 | 0820 | 23.9 | 28.1 | 220 | 80 | 1.7 | .01 |
| 9 | 0850 | 24.6 | 30.4 | 140 | 120 | 1.9 | .04 | 25 | 0940 | 49.3 | 59.2 | 270 | 210 | 3.2 | .03 |
| 10 | 0825 | 23.5 | 29.2 | 160 | 150 | .9 | .0 | 28 | 0810 | 70.5 | 85.0 | 150 | 120 | 3.1 | .07 |
| 14 | 0812 | 95.7 | 117.7 | 370 | 200 | 4.2 | .03 | 29 | 0805 | 23.9 | 28.0 | 150 | 180 | 1.2 | .1 |
| 15 | 0815 | 24.0 | 29.8 | 240 | 120 | 2.6 | .05 | 30 | 0820 | 24.2 | 29.6 | 80 | 100 | 1.1 | .07 |
| | | | | | | | | Average | | | | 320 | 160 | 3.4 | .04 |

[a] Radon concentrations are derived from alpha measurements determined immediately after the sampling period (24–96 hours) has ceased. Reported radon concentrations have been corrected for any thoron daughter interferences. Twice the standard deviation ($2\sigma$) falls between ±20 and ±60 $\mu\mu c/m^3$.

[b] Radon concentrations are derived from alpha measurements made in the afternoon approximately 7 hours (3 p.m.) after the new sampling period has begun. Reported radon concentrations are uncorrected for any thoron daughter interferences. Twice the standard deviation ($2\sigma$) falls between ±10.0 and ±30.0 $\mu\mu c/m^3$.

[c] Thoron concentrations are derived from alpha measurements made from the same filters used in footnote (a), above, but are counted approximately 7 hours after the sampling period has ceased. Twice the standard deviation ($2\sigma$) falls between ±0.2 and ±0.5 $\mu\mu c/m^3$.

[d] Gross beta concentrations are based on measurements made at least 4 days after each sampling period (24–96 hours) has ceased. Twice the standard deviation ($2\sigma$) falls between ±0.0 and ±0.1 $\mu\mu c/m^3$.

## National Air Sampling Network

*Division of Air Pollution, Public Health Service*

The Public Health Service developed its National Air Sampling Network in 1953 to secure basic data on the nature and extent of air pollution throughout the United States, and to detect trends in levels of pollution with respect to time, location, population density, climate, and other factors associated with air quality.

The current basic network consists of 103 sampling stations operating every year in 66 large cities and 37 nonurban areas. In addition to these every-year stations, 126 cities have stations which operate every other year. Thus, there are 229 sampling stations in all, of which about 166 are active in any given year. A list of National Air Sampling Network stations appeared in *Radiological Health Data*, Volume 1, No. 2.

The network stations are manned by Federal, State, and local agencies cooperating with the Division of Air Pollution, PHS. Twenty-four-hour samples of suspended particulate matter, representing approximately 2,000 cubic meters of air, are collected on glass-fiber filters on a biweekly random sampling schedule. The analyses of these samples include the measurement of total quantity of suspended particulate matter, the organic matter soluble in benzene, and gross beta radioactivity. Selected samples are analyzed also for nitrates and sulfates and for a number of metals.

Quarterly reports of individual sample data and annual summaries are distributed to all participating agencies and State health departments. A comprehensive report on the first 5 years of operation of the network is contained in the publication, "Air Pollution Measurements of the National Air Sampling Network," Public Health Service Publication No. 637, 1958, for sale by the Superintendent of Documents, U.S. Government Printing Office, Washington 25, D.C., price $2. Gross beta activity data, by States, for the years 1953 through 1958 were submitted by Dr. F. J. Weber, Chief, Division of Radiological Health, Public Health Service, in testimony before the Joint Committee on Atomic Energy "Hearings on Fallout from Nuclear Weapons Tests," Volume 1, May 1959, pages 173–185.

Previous data on gross beta activities of particulates in air were published in *Radiological Health Data*, Volume I, Nos. 7 and 8, and Volume II, No. 1. The fourth-quarter 1960 data and the 1960 annual summary data are presented in tables 3 and 4, respectively.

Data from several stations are not included in the annual summary due to the small number of samples collected during 1960. Most of the data

FIGURE 2.—PUBLIC HEALTH SERVICE NATIONAL AIR SAMPLING NETWORK SAMPLING STATIONS

from these stations have been published in previous quarterly reports. In the 1960 annual summary data for San Juan, P.R. (table 4), the maximum value is 26.3 $\mu\mu c/m^3$ and the average is 1.3 $\mu\mu c/m^3$. The results for the sample with the high activity were not included in the first quarter because the sample was held in the counting room for further study and the results were not available in time for publishing in *Radiological Health Data*, Volume I, No. 8. The high value, which is outstanding for the year, was apparently due to the first French test.

TABLE 3.—GROSS BETA RADIOACTIVITY IN AIR

*National Air Sampling Network, Public Health Service, Fourth Quarter 1960*

[$\mu\mu c$ per cubic meter]

| Station location | Number of samples | Minimum | Maximum | Average | Station location | Number of samples | Minimum | Maximum | Average |
|---|---|---|---|---|---|---|---|---|---|
| Hartford, Conn. | 6 | <0.1 | 0.1 | 0.1 | Orange County, Vt.[1] | 6 | <.1 | .1 | .1 |
| New Haven, Conn. | 5 | <.1 | .1 | .1 | Wilmington, Del. | 6 | <.1 | .1 | .1 |
| Stanford, Conn. | 6 | <.1 | .1 | .1 | Kent County, Del.[1] | 6 | <.1 | .1 | .1 |
| Bridgeport, Conn. | 5 | <.1 | .1 | .1 | Elizabeth, N.J. | 6 | <.1 | .1 | .1 |
| Portland, Maine | 6 | <.1 | .1 | .1 | Camden, N.J. | 6 | <.1 | .1 | .1 |
| Acadia National Park, Maine[1] | 5 | <.1 | .1 | <.1 | Trenton, N.J. | 1 | .1 | .1 | .1 |
| Boston, Mass. | 6 | <.1 | .1 | .1 | East Orange, N.J. | 6 | <.1 | .1 | .1 |
| Lawrence, Mass. | 5 | <.1 | .1 | .1 | Newark, N.J. | 5 | <.1 | .1 | .1 |
| Lynn, Mass. | 6 | <.1 | .1 | .1 | New York, N.Y. | 6 | <.1 | .1 | .1 |
| Somerville, Mass. | 6 | <.1 | .1 | .1 | Binghamton, N.Y. | 6 | <.1 | .1 | .1 |
| Fall River, Mass. | 7 | .1 | .2 | .1 | Schenectady, N.Y. | 5 | <.1 | .1 | .1 |
| Quincy, Mass. | 5 | <.1 | .2 | .1 | Syracuse, N.Y. | 4 | <.1 | .1 | .1 |
| Springfield, Mass. | 6 | <.1 | .2 | .1 | Utica, N.Y. | 6 | <.1 | .1 | <.1 |
| Manchester, N.H. | 6 | <.1 | .1 | <.1 | Albany, N.Y. | 6 | <.1 | .1 | .1 |
| Coos County, N.H.[1] | 6 | <.1 | .1 | .1 | Rochester, N.Y. | 6 | <.1 | .1 | .1 |
| Providence, R.I. | 6 | <.1 | .1 | .1 | Niagara Falls, N.Y. | 4 | <.1 | .2 | .1 |
| Washington County, R.I. | 7 | <.1 | .1 | .1 | New Rochelle, N.Y. | 7 | <.1 | .2 | .1 |
| Burlington, Vt. | 7 | <.1 | .1 | <.1 | Troy, N.Y. | 6 | <.1 | .1 | .1 |

[1] Nonurban station.

TABLE 3.—GROSS BETA RADIOACTIVITY IN AIR—Continued

| Station location | Number of samples | Minimum | Maximum | Average |
|---|---|---|---|---|
| Massena, N.Y. | 6 | <.1 | .1 | .1 |
| Glen Cove, N.Y. | 4 | <.1 | .1 | .1 |
| Elmira, N.Y. | 7 | <.1 | .1 | .1 |
| Mount Vernon, N.Y. | 6 | <.1 | .1 | .1 |
| Cape Vincent, N.Y. | 6 | <.1 | .1 | .1 |
| Philadelphia, Pa. | 6 | <.1 | .1 | .1 |
| Pittsburgh, Pa. | 6 | <.1 | .1 | .1 |
| Harrisburg, Pa. | 6 | <.1 | .1 | .1 |
| Reading, Pa. | 6 | <.1 | .2 | .1 |
| Wilkes-Barre, Pa. | 6 | .1 | .2 | .1 |
| Clarion County, Pa.[1] | 6 | <.1 | .2 | .1 |
| Washington, D.C. | 6 | <.1 | .1 | .1 |
| Louisville, Ky. | 2 | .1 | .1 | .1 |
| Baltimore, Md. | 7 | <.1 | .1 | .1 |
| Calvert County, Md.[1] | 6 | <.1 | .1 | .1 |
| Charlotte, N.C. | 7 | <.1 | .2 | .1 |
| Winston-Salem, N.C. | 5 | .1 | .1 | .1 |
| Asheville, N.C. | 6 | <.1 | .1 | .1 |
| Cape Hatteras, N.C.[1] | 7 | <.1 | .1 | .1 |
| San Juan, P.R. | 6 | <.1 | .1 | .1 |
| Loquillo Mountains, P.R.[1] | 6 | <.1 | .1 | <.1 |
| Norfolk, Va. | 6 | .1 | .1 | .1 |
| Hampton, Va. | 7 | .1 | .1 | .1 |
| Danville, Va. | 6 | <.1 | .1 | .1 |
| Shenandoah National Park, Va.[1] | 6 | .1 | .1 | .1 |
| Charleston, W. Va. | 6 | <.1 | .2 | .1 |
| Huntington, W. Va. | 6 | .1 | .1 | .1 |
| Birmingham, Ala. | 6 | .1 | .1 | 1 |
| Mobile, Ala. | 6 | .1 | .1 | .1 |
| Tampa, Fla. | 6 | .1 | .1 | .1 |
| Jacksonville, Fla. | 6 | .1 | .1 | .1 |
| Florida Keys, Fla.[1] | 5 | <.1 | .1 | <.1 |
| Atlanta, Ga. | 5 | <.1 | .1 | .1 |
| Columbus, Ga. | 6 | <.1 | .1 | .1 |
| Macon, Ga. | 6 | <.1 | .1 | .1 |
| Jackson, Miss.[1] | 6 | .1 | .2 | .1 |
| Jackson County, Miss. | 6 | .1 | .1 | .1 |
| Columbia, S.C. | 1 | .1 | .1 | .1 |
| Greenville, S.C. | 7 | .1 | .1 | .1 |
| Richland County, S.C.[1] | 7 | <.1 | .1 | .1 |
| Chattanooga, Tenn. | 5 | <.1 | .1 | .1 |
| Nashville, Tenn. | 6 | <.1 | .1 | .1 |
| Memphis, Tenn. | 5 | .1 | .1 | .1 |
| Chicago, Ill. | 8 | <.1 | .1 | .1 |
| Springfield, Ill. | 7 | <.1 | .1 | .1 |
| Peoria, Ill. | 3 | .1 | .2 | .1 |
| East Chicago, Ind. | 6 | <.1 | .2 | .1 |
| Evansville, Ind. | 6 | <.1 | .1 | .1 |
| Fort Wayne, Ind. | 6 | <.1 | .1 | .1 |
| Indianapolis, Ind. | 5 | .1 | .1 | .1 |
| Gary, Ind. | 5 | .1 | .1 | .1 |
| Montgomery County, Ind.[1] | 6 | <.1 | .1 | .1 |
| Detroit, Mich. | 6 | <.1 | .1 | .1 |
| Kalamazoo, Mich. | 5 | <.1 | .1 | .1 |
| Lansing, Mich. | 6 | <.1 | .1 | .1 |
| Saginaw, Mich. | 6 | <.1 | .2 | .1 |
| Cincinnati, Ohio | 5 | .1 | .1 | .1 |
| Youngstown, Ohio | 6 | .1 | .1 | .1 |
| Cleveland, Ohio | 6 | <.1 | .2 | .1 |
| Columbus, Ohio | 6 | <.1 | .2 | .1 |
| Lorain, Ohio | 6 | <.1 | .1 | .1 |
| Akron, Ohio | 6 | <.1 | .1 | .1 |
| Dayton, Ohio | 6 | .1 | .2 | .1 |
| Springfield, Ohio | 6 | .1 | .1 | .1 |
| Milwaukee, Wis. | 6 | <.1 | .1 | .1 |
| Racine, Wis. | 5 | <.1 | .1 | .1 |
| Door County, Wis.[1] | 6 | <.1 | .1 | .1 |
| Des Moines, Iowa | 6 | <.1 | .2 | .1 |
| Clayton County, Iowa[1] | 6 | <.1 | .2 | .1 |
| Kansas City, Kans. | 6 | <.1 | .1 | .1 |
| Wichita, Kans. | 5 | <.1 | .2 | .1 |
| Minneapolis, Minn. | 7 | <.1 | .1 | .1 |
| St. Paul, Minn. | 6 | <.1 | .1 | .1 |
| Kansas City, Mo. | 6 | <.1 | .1 | .1 |
| St Louis, Mo. | 6 | <.1 | .1 | .1 |
| Omaha, Nebr. | 6 | <.1 | .1 | .1 |
| Lincoln, Nebr. | 4 | <.1 | .1 | .1 |
| Thomas County, Nebr.[1] | 7 | <.1 | .1 | .1 |
| Bismarck, N. Dak. | 6 | <.1 | .1 | .1 |
| Ward County, N. Dak.[1] | 7 | <.1 | .1 | <.1 |
| Sioux Falls, S. Dak. | 6 | <.1 | .1 | .1 |
| Black Hills Forest, S. Dak.[1] | 3 | .1 | .1 | .1 |
| Little Rock, Ark. | 6 | .1 | .1 | .1 |
| Montgomery County, Ark.[1] | 6 | .1 | .1 | .1 |
| New Orleans, La. | 6 | <.1 | .1 | .1 |
| Baton Rouge, La. | 6 | .1 | .1 | .1 |
| Albuquerque, N. Mex. | 6 | .1 | .5 | .2 |
| Colfax County, N. Mex.[1] | 7 | <.1 | .2 | .1 |
| Tulsa, Okla. | 7 | <.1 | .1 | .1 |
| Oklahoma City, Okla. | 6 | <.1 | .1 | .1 |
| Cherokee County, Okla.[1] | 6 | <.1 | .1 | .1 |
| Fort Worth, Tex. | 6 | <.1 | .1 | .1 |
| Houston, Tex. | 6 | <.1 | .1 | .1 |
| Dallas, Tex. | 5 | <.1 | .1 | .1 |
| San Antonio, Tex. | 5 | <.1 | .1 | .1 |
| El Paso, Tex. | 6 | <.1 | .2 | .1 |
| Corpus Christi, Tex. | 6 | <.1 | .1 | .1 |
| Waco, Tex. | 6 | <.1 | .1 | .1 |
| Denver, Colo. | 6 | <.1 | .2 | .1 |
| Montezuma County, Colo.[1] | 6 | <.1 | .3 | .2 |
| Boise, Idaho. | 5 | <.1 | .1 | .1 |
| Butte County, Idaho.[1] | 6 | <.1 | .3 | .1 |
| Helena, Mont. | 6 | <.1 | .1 | .1 |
| Glacier National Park, Mont.[1] | 6 | <.1 | .1 | <.1 |
| Salt Lake City, Utah | 7 | <.1 | .2 | .1 |
| Cheyenne, Wyo. | 6 | <.1 | .4 | .1 |
| Yellowstone Park, Wyo.[1] | 7 | <.1 | .1 | .1 |
| Anchorage, Alaska | 6 | <.1 | .1 | .1 |
| Point Woronzof, Alaska[1] | 6 | <.1 | .1 | .1 |
| Phoenix, Ariz. | 7 | <.1 | .2 | .1 |
| Tucson, Ariz. | 6 | <.1 | .2 | .1 |
| Maricopa County, Ariz.[1] | 7 | <.1 | .1 | .1 |
| Grand Canyon Park, Ariz.[1] | 7 | <.1 | .1 | .1 |
| Los Angeles, Calif. | 6 | <.1 | .3 | .1 |
| San Francisco, Calif. | 6 | <.1 | .1 | <.1 |
| Pasadena, Calif. | 6 | .1 | .1 | .1 |
| San Diego, Calif. | 6 | .1 | .2 | .1 |
| Burbank, Calif. | 6 | <.1 | .2 | .1 |
| Fresno, Calif. | 5 | <.1 | .1 | .1 |
| Oakland, Calif. | 5 | <.1 | .1 | .1 |
| Sacramento, Calif. | 6 | .1 | .1 | .1 |
| Richmond, Calif. | 6 | <.1 | .1 | .1 |
| Humboldt County, Calif.[1] | 5 | <.1 | .1 | .1 |
| Honolulu, Hawaii | 6 | <.1 | .1 | <.1 |
| Barbers Point, Ewa, Hawaii[1] | 6 | <.1 | .1 | <.1 |
| Las Vegas, Nev. | 5 | .1 | .2 | .2 |
| White Pine County, Nev.[1] | 7 | .1 | .3 | .1 |
| Portland, Oreg. | 5 | <.1 | .1 | <.1 |
| Curry County, Oreg.[1] | 4 | <.1 | .1 | <.1 |
| Seattle, Wash. | 6 | <.1 | .1 | <.1 |
| Tacoma, Wash. | 6 | <.1 | .1 | .1 |

[1] Nonurban station.

## TABLE 4.—GROSS BETA RADIOACTIVITY IN AIR

*National Air Sampling Network, Public Health Service, Annual Summary 1960*

[$\mu\mu$c per cubic meter]

| Station location | Number of samples | Minimum | Maximum | Average | Station location | Number of samples | Minimum | Maximum | Average |
|---|---|---|---|---|---|---|---|---|---|
| Hartford, Conn | 26 | <0.1 | 0.3 | 0.1 | Fort Wayne, Ind | 26 | <.1 | .3 | .1 |
| New Haven, Conn | 25 | <.1 | .3 | .1 | Indianapolis, Ind | 25 | .1 | .4 | .2 |
| Stamford, Conn | 26 | <.1 | .4 | .1 | Gary, Ind | 24 | <.1 | .3 | .1 |
| Bridgeport, Conn | 24 | <.1 | .2 | .1 | Montgomery County, Ind.[1] | 26 | <.1 | .4 | .1 |
| Portland, Maine | 24 | <.1 | .2 | .1 | Detroit, Mich | 26 | <.1 | .3 | .1 |
| Acadia National Park, Maine[1] | 25 | <.1 | .4 | .1 | Kalamazoo, Mich | 25 | <.1 | .3 | .1 |
| Boston, Mass | 26 | <.1 | .3 | .1 | Lansing, Mich | 25 | <.1 | .2 | .1 |
| Lawrence, Mass | 25 | <.1 | .2 | .1 | Saginaw, Mich | 26 | <.1 | .4 | .1 |
| Lynn, Mass | 26 | <.1 | .1 | .1 | Cincinnati, Ohio | 24 | <.1 | .3 | .1 |
| Somerville, Mass | 25 | <.1 | .2 | .1 | Youngstown, Ohio | 26 | <.1 | .2 | .1 |
| Fall River, Mass | 23 | <.1 | .3 | .1 | Cleveland, Ohio | 26 | <.1 | .3 | .1 |
| Quincy, Mass | 23 | <.1 | .3 | .1 | Columbus, Ohio | 25 | <.1 | .4 | .1 |
| Springfield, Mass | 21 | <.1 | .3 | .1 | Lorain, Ohio | 26 | <.1 | .3 | .1 |
| Manchester, N.H | 21 | <.1 | .3 | .1 | Akron, Ohio | 26 | <.1 | .3 | .1 |
| Coos County, N.H.[1] | 24 | <.1 | .2 | .1 | Dayton, Ohio | 26 | <.1 | .3 | .1 |
| Providence, R.I | 26 | <.1 | .3 | .1 | Springfield, Ohio | 26 | .1 | .4 | .2 |
| Washington County, R.I.[1] | 27 | <.1 | .2 | .1 | Milwaukee, Wis | 24 | <.1 | .4 | .1 |
| Burlington, Vt | 25 | <.1 | .3 | .1 | Racine, Wis | 23 | <.1 | .3 | .1 |
| Orange County, Vt.[1] | 25 | <.1 | .3 | .1 | Door County, Wis.[1] | 26 | <.1 | .3 | .1 |
| Wilmington, Del | 24 | <.1 | .5 | .2 | Des Moines, Iowa | 25 | <.1 | .4 | .2 |
| Kent County, Del.[1] | 20 | <.1 | .2 | .1 | Clayton County, Iowa[1] | 26 | <.1 | .4 | .1 |
| Elizabeth, N.J | 24 | <.1 | .2 | .1 | Kansas City, Kans | 26 | <.1 | .3 | .1 |
| Camden, N.J | 25 | <.1 | .2 | .1 | Wichita, Kans | 22 | <.1 | .5 | .2 |
| East Orange, N.J | 20 | <.1 | .2 | .1 | Minneapolis, Minn | 26 | <.1 | .3 | .1 |
| Newark, N.J | 25 | <.1 | .2 | .1 | St. Paul, Minn | 25 | <.1 | .3 | .1 |
| New York, N.Y | 25 | <.1 | .3 | .1 | Kansas City, Mo | 26 | <.1 | .3 | .2 |
| Binghamton, N.Y | 24 | <.1 | .3 | .1 | St. Louis, Mo | 26 | <.1 | .3 | .1 |
| Schenectady, N.Y | 23 | <.1 | .2 | .1 | Omaha, Nebr | 26 | <.1 | .4 | .1 |
| Syracuse, N.Y | 26 | <.1 | .3 | .1 | Lincoln, Nebr | 25 | <.1 | .3 | .1 |
| Utica, N.Y | 25 | <.1 | .2 | .1 | Thomas County, Nebr.[1] | 26 | <.1 | .4 | .1 |
| Albany, N.Y | 26 | <.1 | .2 | .1 | Bismarck, N. Dak | 25 | <.1 | .4 | .1 |
| Rochester, N.Y | 26 | <.1 | .3 | .1 | Ward County, N. Dak.[1] | 23 | <.1 | .3 | .1 |
| Niagara Falls, N.Y | 19 | <.1 | .5 | .2 | Sioux Falls, S. Dak.[1] | 22 | <.1 | .5 | .1 |
| New Rochelle, N.Y | 26 | <.1 | .2 | .1 | Black Hills Forest, S. Dak.[1] | 19 | <.1 | .3 | .1 |
| Troy, N.Y | 22 | <.1 | .2 | .1 | Little Rock, Ark | 26 | <.1 | .3 | .1 |
| Massena, N.Y | 25 | <.1 | .2 | .1 | Montgomery County, Ark.[1] | 26 | <.1 | .4 | .1 |
| Glen Cove, N.Y | 22 | <.1 | .2 | .1 | New Orleans, La | 26 | <.1 | .3 | .1 |
| Elmira, N.Y | 26 | <.1 | .4 | .1 | Baton Rouge, La | 26 | <.1 | .7 | .2 |
| Mount Vernon, N.Y | 20 | <.1 | .3 | .1 | Albuquerque, N. Mex | 25 | <.1 | .5 | .2 |
| Cape Vincent, N.Y.[1] | 22 | <.1 | .2 | .1 | Colfax County, N. Mex.[1] | 22 | <.1 | .3 | .1 |
| Philadelphia, Pa | 26 | <.1 | .4 | .1 | Tulsa, Okla | 17 | <.1 | .3 | .1 |
| Pittsburgh, Pa | 23 | <.1 | .2 | .1 | Oklahoma City, Okla | 23 | <.1 | .3 | .2 |
| Harrisburg, Pa | 25 | <.1 | .2 | .1 | Cherokee County, Okla.[1] | 24 | <.1 | .4 | .2 |
| Reading, Pa | 25 | <.1 | .2 | .1 | Fort Worth, Tex | 26 | <.1 | .4 | .1 |
| Wilkes-Barre, Pa | 25 | <.1 | .3 | .1 | Houston, Tex | 26 | <.1 | .5 | .1 |
| Clarion County, Pa.[1] | 26 | <.1 | .4 | .1 | Dallas, Tex | 22 | <.1 | .4 | .1 |
| Washington, D.C | 22 | <.1 | .3 | .2 | San Antonio, Tex | 23 | <.1 | .4 | .1 |
| Baltimore, Md | 25 | <.1 | .3 | .1 | El Paso, Tex | 26 | <.1 | .8 | .2 |
| Calvert County, Md.[1] | 24 | <.1 | .3 | .1 | Corpus Christi, Tex | 26 | <.1 | .4 | .1 |
| Charlotte, N.C | 26 | <.1 | .4 | .2 | Waco, Tex | 25 | <.1 | .2 | .1 |
| Winston Salem, N.C | 25 | <.1 | .4 | .2 | Denver, Colo | 25 | <.1 | .4 | .2 |
| Asheville, N.C | 26 | <.1 | .4 | .2 | Montezuma County, Colo.[1] | 24 | <.1 | .8 | .2 |
| Cape Hatteras, N.C.[1] | 24 | <.1 | .2 | .1 | Boise, Idaho | 24 | <.1 | .3 | .1 |
| San Juan, P.R | 23 | <.1 | 26.3 | 1.3 | Butte County, Idaho.[1] | 22 | <.1 | .3 | .2 |
| Loquillo Mountains, P.R.[1] | 24 | <.1 | .6 | .1 | Helena, Mont | 26 | <.1 | .3 | .1 |
| Norfolk, Va | 26 | <.1 | .2 | .1 | Glacier National Park, Mont.[1] | 26 | <.1 | .4 | .1 |
| Hampton, Va | 26 | <.1 | .4 | .2 | Salt Lake City, Utah | 25 | <.1 | .6 | .2 |
| Danville, Va | 25 | <.1 | .3 | .1 | Cheyenne, Wyo | 23 | <.1 | .4 | .1 |
| Shenandoah National Park, Va.[1] | 26 | <.1 | .3 | .1 | Yellowstone Park, Wyo.[1] | 21 | <.1 | .3 | .1 |
| | | | | | Anchorage, Alaska | 26 | <.1 | .2 | .1 |
| Charleston, W. Va | 25 | <.1 | .5 | .2 | Point Woronzof, Alaska[1] | 26 | <.1 | .2 | .1 |
| Huntington, W. Va | 24 | <.1 | .3 | .1 | Phoenix, Ariz | 25 | <.1 | .4 | .2 |
| Birmingham, Ala | 25 | <.1 | .4 | .1 | Tucson, Ariz | 25 | .1 | 1.9 | .3 |
| Mobile, Ala | 25 | <.1 | .4 | .1 | Maricopa County, Ariz.[1] | 26 | <.1 | .5 | .2 |
| Tampa, Fla | 26 | <.1 | 1.2 | .2 | Grand Canyon Park, Ariz.[1] | 21 | <.1 | .4 | .2 |
| Jacksonville, Fla | 26 | <.1 | .5 | .2 | Los Angeles, Calif | 25 | <.1 | .5 | .1 |
| Florida Keys, Fla.[1] | 21 | <.1 | .4 | .1 | San Francisco, Calif | 26 | <.1 | .3 | .1 |
| Atlanta, Ga | 23 | <.1 | .4 | .2 | Pasadena, Calif | 26 | <.1 | .3 | .1 |
| Columbus, Ga | 25 | <.1 | .4 | .2 | San Diego, Calif | 26 | <.1 | .7 | .1 |
| Macon, Ga | 26 | <.1 | .4 | .1 | Burbank, Calif | 26 | <.1 | .9 | .2 |
| Jackson, Miss.[1] | 24 | <.1 | .3 | .1 | Fresno, Calif | 25 | <.1 | .4 | .2 |
| Jackson County, Miss | 23 | <.1 | .3 | .1 | Oakland, Calif | 24 | <.1 | .3 | .1 |
| Columbia, S.C | 23 | <.1 | .4 | .2 | Sacramento, Calif | 26 | <.1 | .6 | .2 |
| Greenville, S.C | 25 | <.1 | .5 | .2 | Richmond, Calif | 26 | <.1 | .5 | .1 |
| Richland County, S.C.[1] | 26 | <.1 | .4 | .1 | Humboldt County, Calif.[1] | 20 | <.1 | .2 | .1 |
| Chattanooga, Tenn | 25 | <.1 | .5 | .2 | Honolulu, Hawaii | 26 | <.1 | .3 | .1 |
| Nashville, Tenn | 26 | <.1 | .4 | .2 | Barbers Point, Ewa County, Hawaii[1] | 26 | <.1 | .6 | .1 |
| Memphis, Tenn | 25 | <.1 | .4 | .1 | Las Vegas, Nev | 21 | <.1 | .5 | .2 |
| Chicago, Ill | 22 | <.1 | .3 | .1 | White Pine County, Nev.[1] | 25 | .1 | .8 | .2 |
| Springfield, Ill | 20 | <.1 | .3 | .1 | Portland, Oreg | 24 | <.1 | .2 | .1 |
| Peoria, Ill | 19 | <.1 | .4 | .2 | Curry County, Oreg | 19 | <.1 | .2 | .1 |
| East Chicago, Ind | 23 | <.1 | .2 | .1 | Tacoma, Wash | 23 | <.1 | .3 | .1 |
| Evansville, Ind | 26 | <.1 | .8 | .2 | | | | | |

[1] Nonurban station.

## Gross Beta Radioactivity in Precipitation

*National Air Sampling Network, Precipitation Collection Section, Public Health Service*

During 1959 a precipitation collection and analysis program was established by the Weather Bureau Research Station in Cincinnati, Ohio, and the National Air Sampling Network. The collection stations are located at Weather Bureau offices or airport stations. Monthly composite samples of precipitation are collected at 30 stations and forwarded to the network laboratory for analysis. A list of these precipitation collection stations is given below. Samples are analyzed for total solids and a large number of metals and nonmetals. In addition, samples representing 85 percent or more of the official rainfall recorded at the collecting stations are analyzed for gross beta radioactivity if a large enough volume remains after the requirements for the chemical analysis have been met.

PRECIPITATION COLLECTION STATIONS

*National Air Sampling Network*

Alabama: Montgomery
California: Santa Maria
Colorado: Grand Junction
Florida: Tampa
Idaho: Pocatello
Illinois:
  Chicago (Midway Airport)
  Chicago (O'Hare Airport)
Louisiana: Lake Charles
Maine: Caribou
Maryland: Silver Hill
Massachusetts: Nantucket
Michigan: Sault Ste. Marie
Minnesota: St. Cloud
Missouri: Columbia
Montana: Glasgow
Nebraska: Grand Island
Nevada: Las Vegas
New York: Albany
North Carolina: Cape Hatteras
Ohio:
  Cincinnati (research station)
  Cincinnati (airport)
Pennsylvania: Philadelphia
South Carolina:
  Charleston
  Greenville
Tennessee: Nashville
Texas:
  Brownsville
  San Angelo
  Amarillo
Virginia: Sterling
Washington: Tatoosh Island

TABLE 5.—GROSS BETA RADIOACTIVITY OF PRECIPITATION

*National Air Sampling Network, Public Health Service, Fourth Quarter 1960*

| Station | October | | November | | December | | Station | October | | November | | December | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | μμc/liter | μμc/m² | μμc/liter | μμc/m² | μμc/liter | μμc/m² | | μμc/liter | μμc/m² | μμc/liter | μμc/m² | μμc/liter | μμc/m² |
| Brownsville, Tex. | (•) | (•) | (•) | (•) | 5 | 300 | Nashville, Tenn. | (•) | (•) | 12 | 800 | 7 | 600 |
| Caribou, Maine | (•) | (•) | (•) | (•) | 6 | 500 | Philadelphia, Pa. | 18 | 1,200 | (•) | (•) | 12 | 900 |
| Cincinnati, Ohio (airport) | 17 | 1,600 | 19 | 1,100 | 11 | 600 | San Angelo, Tex. | 3 | 300 | (•) | (•) | (•) | (•) |
| Cincinnati, Ohio (WBRS) | 12 | 800 | (•) | (•) | (•) | (•) | Sault Ste. Marie, Mich. | 15 | 800 | (•) | (•) | (•) | (•) |
| Lake Charles, La. | 9 | 1,100 | 5 | 600 | 5 | 1,000 | Sterling, Va. | (•) | (•) | (•) | (•) | 7 | 400 |
| Nantucket, Mass. | 9 | 600 | 8 | 700 | (•) | (•) | Tatoosh, Wash. | (•) | (•) | 19 | 4,200 | 7 | 1,300 |
| | | | | | | | Cape Hatteras, N.C. | (•) | (•) | (•) | (•) | 11 | 1,400 |

• No data available due to low collection efficiency or inadequate sample.

## Radioactivity Measurements in Air

*U.S. Naval Research Laboratory*

Radioactivity measurements of air-filter samples collected at various sites along the 80th meridian (West) are made by the U.S. Naval Research Laboratory under a program partially financed by the Atomic Energy Commission.

The daily record of fission product beta activity during November 1960 is shown in table 6, and the radioactivity profile for the same month is shown in figure 3. All radioactivity concentrations are given in disintegrations per minute per cubic meter of air at the collecting site (2.2 disintegrations per minute per cubic meter equals 1 micromicrocurie per cubic meter).

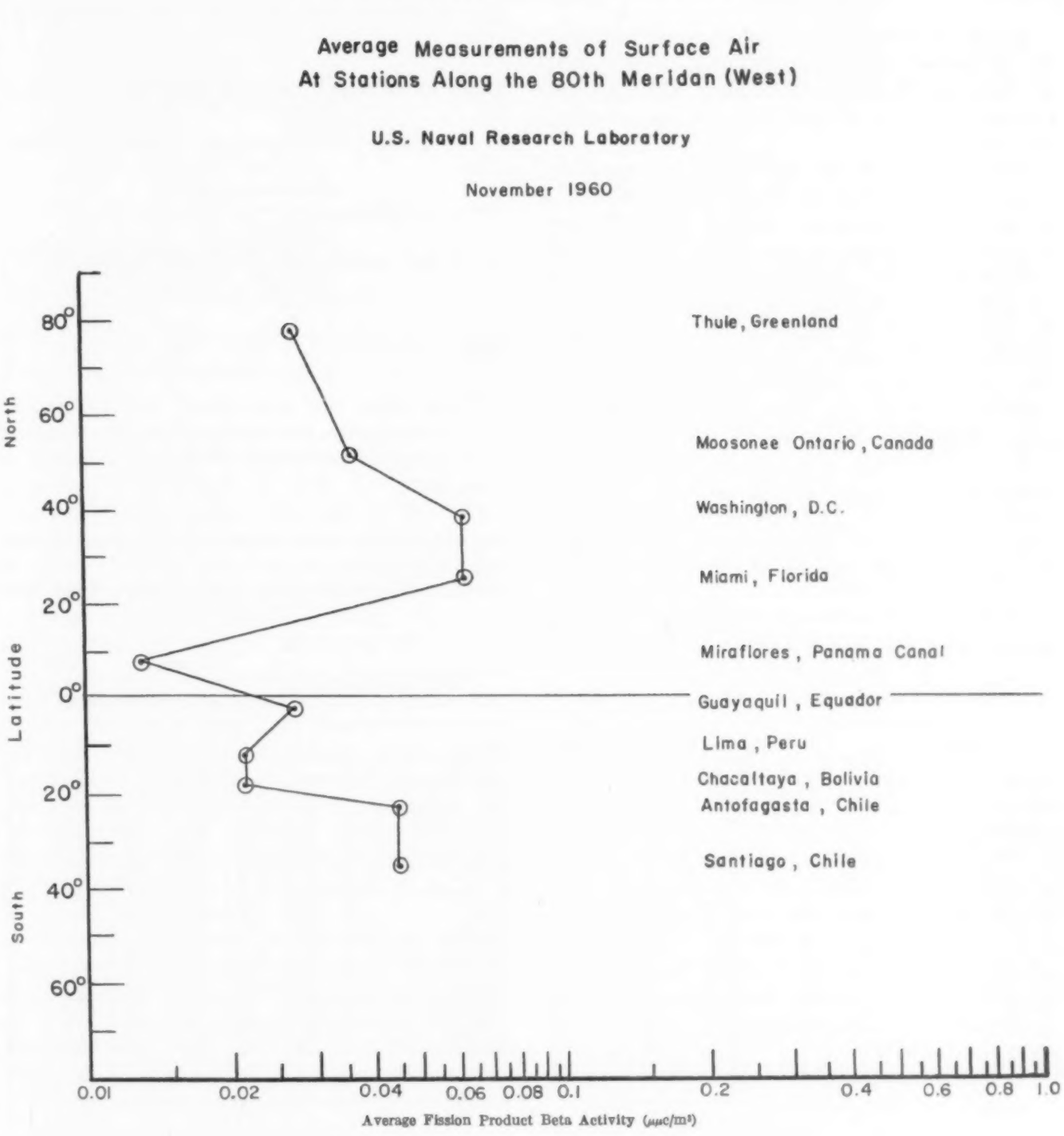
TABLE 6.—DAILY RECORD OF FISSION PRODUCT BETA ACTIVITY COLLECTED BY AIR FILTRATION

*U.S. Naval Research Laboratory, November 1960*

[dpm/m³]

| Day | Punta Arenas, Chile | Puerto Montt, Chile | Santiago, Chile | Antofagasta, Chile | Chacaltaya, Bolivia | Lima, Peru | Guayaquil, Ecuador | Miraflores, Panama Canal | Mauna Loa, Hawaii | Miami, Florida | Washington, D.C. | Moosonee Ontario, Canada | Thule, Greenland |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | ---- | 0.06 | 0.13 | 0.18 | 0.08 | 0.02 | 0.06 | 0.01 | 0.09 | 0.04 | 0.16 | 0.11 | 0.04 |
| 2 | ---- | .06 | .13 | .18 | .06 | .02 | .06 | .01 | .09 | .04 | .13 | .11 | .04 |
| 3 | ---- | .06 | .07 | .13 | .04 | .10 | .06 | .01 | .08 | .23 | .17 | .01 | .03 |
| 4 | ---- | .06 | .07 | .13 | .05 | .10 | .09 | .01 | .08 | .23 | .17 | .01 | .03 |
| 5 | ---- | .06 | .08 | .09 | ---- | .04 | .09 | .04 | .11 | .23 | .11 | .05 | .04 |
| 6 | ---- | .06 | .08 | .09 | .08 | .04 | .09 | .04 | .11 | .23 | .11 | .05 | .04 |
| 7 | ---- | .06 | .08 | .09 | .06 | .04 | .09 | .04 | .11 | .23 | .11 | .05 | .04 |
| 8 | ---- | ---- | .11 | .07 | .06 | .06 | .09 | .04 | .10 | .23 | .07 | .06 | .04 |
| 9 | ---- | ---- | .11 | .07 | .04 | .06 | .10 | .04 | .10 | .23 | .07 | .06 | .09 |
| 10 | ---- | ---- | .10 | .06 | .06 | .05 | .05 | .04 | .04 | .15 | .12 | .10 | .05 |
| 11 | ---- | ---- | .10 | .06 | .04 | .05 | .05 | .04 | .04 | .15 | .12 | .10 | .05 |
| 12 | ---- | ---- | .06 | .08 | .04 | .01 | .05 | .02 | .03 | .10 | .12 | .09 | .06 |
| 13 | ---- | ---- | .06 | .08 | .04 | .01 | .05 | .02 | .03 | .10 | .12 | .09 | .06 |
| 14 | ---- | ---- | .06 | .08 | .04 | .01 | .05 | .02 | .03 | .10 | .12 | .09 | .06 |
| 15 | ---- | ---- | .14 | .10 | .02 | .08 | .07 | .05 | .08 | .09 | .26 | .10 | ---- |
| 16 | ---- | ---- | .14 | .10 | ---- | .08 | .07 | .05 | .08 | .09 | .26 | .10 | ---- |
| 17 | ---- | ---- | .15 | .11 | .03 | .03 | .07 | .03 | .08 | .05 | .18 | .03 | .09 |
| 18 | ---- | ---- | .15 | .11 | .02 | .03 | .07 | .03 | .08 | .05 | .18 | .03 | .09 |
| 19 | ---- | ---- | .10 | .11 | .06 | .03 | .07 | .01 | .05 | .14 | .14 | .08 | .08 |
| 20 | ---- | ---- | .10 | .11 | .06 | .03 | .07 | .01 | .05 | .14 | .14 | .08 | .08 |
| 21 | ---- | ---- | .10 | .11 | .05 | .03 | .06 | .01 | .05 | .14 | .14 | .08 | .08 |
| 22 | ---- | ---- | .13 | .09 | .07 | .07 | .06 | .01 | .05 | .28 | .16 | .12 | ---- |
| 23 | ---- | ---- | .13 | .09 | .06 | .07 | .05 | .01 | .05 | .28 | .16 | .12 | .08 |
| 24 | ---- | ---- | .11 | .11 | .05 | .02 | .05 | .04 | .04 | .18 | .09 | .14 | .08 |
| 25 | ---- | ---- | .11 | .11 | .04 | .02 | .05 | .04 | .04 | .18 | .09 | .14 | .07 |
| 26 | ---- | ---- | .11 | ---- | .04 | .06 | .05 | .04 | .05 | .06 | .11 | .08 | .07 |
| 27 | ---- | ---- | .11 | ---- | .02 | .06 | .05 | .04 | .05 | .06 | .11 | .08 | .06 |
| 28 | ---- | ---- | .11 | ---- | .03 | .06 | .09 | .04 | .05 | .06 | .11 | .08 | .05 |
| 29 | ---- | ---- | .14 | ---- | .02 | ---- | .04 | .02 | .08 | .07 | .11 | .04 | .05 |
| 30 | ---- | ---- | .14 | ---- | .02 | ---- | .04 | .02 | .08 | .07 | .11 | .04 | .10 |
| Mean value | ---- | ---- | .10 | .10 | .05 | .05 | .06 | .03 | .07 | .14 | .14 | .08 | .06 |

FIGURE 3.—PROFILE OF BETA ACTIVITY



# Canadian Radioactive Fallout Study Program

*Department of National Health and Welfare, Dominion of Canada*

As part of its radioactive fallout study program, the Radiation Protection Division, Department of National Health and Welfare, Dominion of Canada, conducts air and precipitation sampling programs.

The operation of the nationwide air sampling program is conducted for two main purposes: (1) to provide a convenient method for the early detection of changes in the fission product concentration in the air and, therefore, of likely changes in the deposition of fission products on the ground; and (2) to obtain data to show the day-to-day and station-to-station variations. This may be useful to meteorologists for a better understanding of the mechanisms involved in radioactive fallout distribution in the atmosphere.

A more detailed discussion of the sampling procedures, methods of analysis, and interpretation of results of the Department's radioactive fallout program is contained in the "Annual Report for 1959," Report No. CNHW (RP–3).

TABLE 7.—TOTAL BETA RADIOACTIVITY IN AIR

*Canadian Radioactive Fallout Study Program, Third Quarter, 1960*

[Average concentration in dpm/m $^3$]

| Station location | July | August | September |
|---|---|---|---|
| Aklavik | 0.22 | 0.11 | 0.09 |
| Calgary | .48 | .34 | .23 |
| Chatham | .39 | .29 | .19 |
| Coral Harbour | .28 | ---- | .08 |
| Edmonton | .41 | .28 | .20 |
| Fort Churchill | .23 | .14 | .11 |
| Fort Williams | .37 | .30 | .17 |
| Fredericton | .30 | .25 | .15 |
| Kapuskasing | .36 | .29 | .15 |
| Montreal | .39 | .32 | .19 |
| Moosonee | .36 | .22 | .15 |
| Ottawa | .41 | .35 | .22 |
| Regina | .36 | .28 | .18 |
| Resolute | .26 | .10 | .06 |
| Saskatoon | .43 | .29 | .20 |
| Shearwater | .30 | .28 | .17 |
| Torbay | .29 | .19 | .14 |
| Toronto | .40 | .35 | .24 |
| Vancouver | .26 | .13 | .19 |
| Whitehorse | .18 | .19 | .10 |
| Windsor | .45 | .37 | .25 |
| Winnipeg | .41 | .30 | .18 |
| Yellowknife | .29 | .19 | .11 |

*Radiological Health Data*, Volume II, No. 1, included tables on total beta activity in air for the period July 1959 through June 1960, and on the total beta activity in precipitation for 1959 and January through June 1960. Tables 7, 8, and 9 present the data for the third quarter 1960.

TABLE 8.—MONTHLY AVERAGE FISSION PRODUCT CONCENTRATION IN AIR

*Canadian Radioactive Fallout Study Program, Third Quarter, 1960*

[Radioactivity in dpm/m $^3$]

| Month | Number of stations operating 50 percent of the time | Minimum average all stations | Maximum average all stations | Average |
|---|---|---|---|---|
| July | 21 | 0.18 | 0.48 | 0.34 |
| August | 22 | .10 | .37 | .25 |
| September | 23 | .06 | .25 | .16 |

These data are reproduced in the present form through the permission of the Department of National Health and Welfare, Dominion of Canada.

TABLE 9.—TOTAL BETA RADIOACTIVITY IN PRECIPITATION

*Canadian Radioactive Fallout Study Program, Third Quarter, 1960*

| Station location | July | | August | | September | |
|---|---|---|---|---|---|---|
| | μμc/liter | Inches | μμc/liter | Inches | μμc/liter | Inches |
| Aklavik | 68.4 | 1.52 | 47.1 | 1.53 | 39.5 | 0.73 |
| Calgary | 112.5 | 1.05 | 103.4 | 1.64 | 18.2 | 1.79 |
| Chatham | ---- | ---- | 433.2 | .40 | 42.6 | 1.95 |
| Coral Harbour | 60.8 | 2.47 | 50.2 | 2.04 | 28.9 | 1.91 |
| Edmonton | 56.2 | 3.35 | 42.6 | 3.72 | 33.4 | 2.39 |
| Fort Churchill | 62.3 | 2.14 | 47.1 | 2.20 | 47.1 | 1.07 |
| Fort Williams | 77.5 | 3.36 | 45.6 | 3.28 | 28.9 | 1.27 |
| Fredericton | 48.6 | 3.97 | 130.7 | .57 | 16.7 | 2.37 |
| Goose Bay | 27.4 | 5.27 | 31.9 | 4.15 | 21.3 | 4.35 |
| Kapuskasing | 50.2 | 2.45 | 24.3 | 4.52 | 31.9 | 2.06 |
| Montreal | 44.1 | 3.45 | 56.2 | 1.19 | 24.3 | 2.50 |
| Moosonee | 51.7 | 3.57 | 63.8 | 1.37 | 24.3 | 3.19 |
| Ottawa | 39.5 | 2.98 | 15.2 | 2.43 | 59.3 | 1.46 |
| Regina | 98.8 | 1.23 | 68.4 | 1.67 | 276.6 | .11 |
| Resolute | 57.8 | 1.06 | 13.7 | 2.92 | ---- | ---- |
| Saskatoon | 15.2 | .47 | 88.2 | .82 | 214.3 | .15 |
| Shearwater | 54.7 | 3.06 | 76.0 | .99 | 7.5 | 2.67 |
| Torbay | 77.5 | .88 | 97.3 | .82 | 30.4 | 2.77 |
| Toronto | 41.0 | 4.11 | 71.4 | 1.23 | 147.4 | .34 |
| Vancouver | 27.5 | .04 | 41.0 | 2.66 | 28.9 | 1.13 |
| Whitehorse | 112.5 | .72 | 56.2 | 1.31 | 102.2 | .61 |
| Windsor | 50.2 | 1.90 | 30.4 | 3.97 | 53.2 | .60 |
| Winnipeg | 126.2 | .67 | 33.4 | 3.09 | 68.4 | .93 |
| Yellowknife | 80.6 | 1.66 | 21.3 | 1.96 | 24.3 | 1.00 |
| Average | 62.7 | ---- | 70.4 | ---- | 59.5 | ---- |

# SECTION II.—FOOD, OTHER THAN MILK

## Strontium 90 and Calcium in U.S. Wheat and Milling Products

*by* J. RIVERA, *Health and Safety Laboratory, U.S. Atomic Energy Commission*

The results of analyses for strontium 90 and calcium in 1959 wheat samples, obtained from nine States, are listed in table 1.[1] Results of analyses on the milling products of the wheat from five of these States are also included. Data on the 1959 wheat crop from six additional States were previously reported in HASL–84.[2]

Using 1958 production statistics, the production-weighted average strontium 90 concentration of the wheat calculated from 15 States' samples in 1959 was $53 \pm 19 \mu\mu c/kg$.[3] This same average computed using data obtained from nine States in 1958 was $62 \pm 27 \mu\mu c/kg$. Although no statistical significance can be attached to the difference between the 1958 average strontium 90 concentration and that for 1959 due to the large standard deviations associated with these averages, one may speculate as to what factors might have influenced the difference.

Strontium 90 fallout in the 30° to 50° N. latitude belt during 1958, from pot and funnel data, is estimated to have been about 0.294 megacuries. In 1959 the strontium 90 deposition in this latitude belt is estimated to have been 0.423 megacurie. One would expect therefore that wheat harvested in 1959 should have had a higher strontium 90 concentration than wheat harvested in 1958. If, however, the deposition during the summer of 1958 and that of 1959 is compared, one finds 0.079 megacurie deposited in 1958 and 0.038 megacurie deposited in 1959. Gummed film data[4] from many of the wheat-growing States also indicate that despite the fact that there was more fallout of strontium 90 in 1959 than in 1958, during the summer harvest months the reverse was true with more strontium 90 being deposited in 1958 than in 1959.

It would seem reasonable to conclude that the strontium 90 concentration in wheat is not wholly dependent on the fallout rate immediately prior to harvest, nor is it wholly dependent on the cumulative strontium 90 content of the soil on which it grows, but rather on a combination of these factors. A reasonable assessment of the relative importance of these two factors may be possible when the 1960 crop is analyzed because it appears that the fallout rate during this year was considerably lower than in the preceding 2 years.

A comparison of the relative distribution of strontium 90 in the 1959 milling products with that obtained in 1958 is shown in table 2. In 1959, as well as in 1958, patent flour had the lowest and bran had the highest strontium 90 concentration. Comparing these concentrations with the concentration of the wheat from which they were milled, one obtains:

| | *1958* [1] | *1959* [2] |
|---|---|---|
| Average $\mu\mu c\ Sr^{90}$/kg of bran / Average $\mu\mu c\ Sr^{90}$/kg of wheat | $\frac{231}{62}=3.73$ | $\frac{163}{47}=3.47$ |
| Average $\mu\mu c\ Sr^{90}$/kg of patent flour / Average $\mu\mu c\ Sr^{90}$/kg of wheat | $\frac{12}{62}=0.19$ | $\frac{9}{47}=0.19$ |

[1] Production weighted average of 9 States.
[2] Production weighted average of 5 States.

[1] The data in table 1 are graphically presented in fig. 4 so that they may be easily compared with the 1958 results included in *Radiological Health Data*, Vol. I, No. 8, pp. 48–50.

[2] *Quarterly Summary Report*, HASL 84, dated Apr. 1, 1960, and presented graphically in *Radiological Health Data*, Vol. I, No. 8.

[3] The 15 States represented in the 1959 sampling had a combined production of 78 percent of the total U.S. wheat production in 1958. The nine States sampled in 1958 had a combined production of 64 percent of the total 1958 U.S. wheat production. *The World Almanac*, 1960.

[4] U.S. Atomic Energy Commission Report, HASL–93, Sept. 5, 1960.

These data indicate that it may be possible to predict the strontium 90 concentration of bran and flour once an analysis of the wheat, from which these products are milled, has been made.

TABLE 1.—1959 WHEAT AND MILLING PRODUCTS

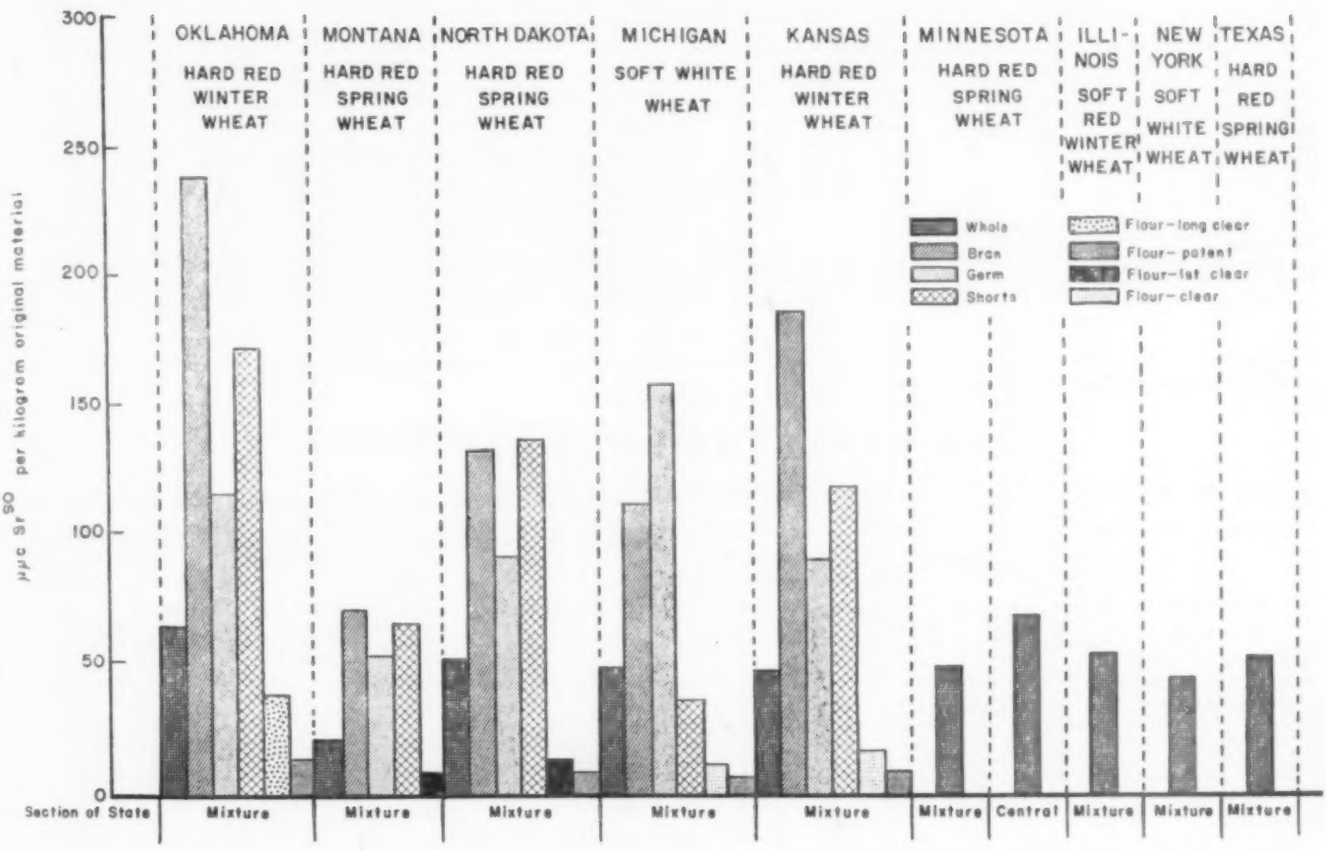
| State | Section of State | Description | Calcium | Strontium 90 | |
|---|---|---|---|---|---|
| | | | gm/kg orig. material | μμc/gm Ca | μμc/kg orig. material |
| Oklahoma | Mixture | Wheat, hard red winter | 0.40 | 159 | 63 |
| | | Bran | 1.23 | 193 | 237 |
| | | Germ | .78 | 148 | 115 |
| | | Shorts | 1.09 | 157 | 171 |
| | | Flour, long clear | .37 | 96 | 37 |
| | | Flour, patent | .18 | 66 | 12 |
| Montana | do | Wheat, hard red spring | .38 | 52 | 20 |
| | | Bran | 1.03 | 68 | 70 |
| | | Germ | .64 | 81 | 52 |
| | | Shorts | 1.03 | 63 | 65 |
| | | Flour, 1st clear | .23 | 29 | 7 |
| | | Flour, patent | | | |
| North Dakota | do | Wheat, hard red spring | .33 | 154 | 51 |
| | | Bran | 1.03 | 126 | 130 |
| | | Germ | .63 | 143 | 91 |
| | | Shorts | 1.10 | 124 | 137 |
| | | Flour, 1st clear | .20 | 65 | 13 |
| | | Flour, patent | .14 | 59 | 8 |
| Michigan | do | Wheat, soft white | .38 | 125 | 48 |
| | | Bran | 1.03 | 110 | 112 |
| | | Germ | .53 | 302 | 159 |
| | | Shorts | .90 | 40 | 36 |
| | | Flour, clear | .28 | 40 | 11 |
| | | Flour, patent | .17 | 36 | 6 |
| Kansas | do | Wheat, hard red winter | .49 | 97 | 47 |
| | | Bran | 1.41 | 132 | 186 |
| | | Germ | .73 | 124 | 90 |
| | | Shorts | 1.18 | 101 | 119 |
| | | Flour, clear | .29 | 53 | 15 |
| | | Flour, patent | .20 | 44 | 9 |
| Illinois | do | Wheat, soft red winter | .38 | 142 | 54 |
| New York | do | Wheat, soft white | .37 | 119 | 44 |
| Minnesota | do | Wheat, hard red spring | .32 | 152 | 49 |
| Do | Central | do | .33 | 210 | 69 |
| Texas | Mixture | do | .51 | 99 | 51 |

TABLE 2.—STRONTIUM-90 MATERIAL BALANCE IN U.S. WHEAT MILLING PRODUCTS

| Wheat fraction | Weight in kg | Strontium 90 | | | |
|---|---|---|---|---|---|
| | | 1958 [1] | | 1959 [2] | |
| | | μμc/kg | μμc in fraction | μμc/kg | μμc in fraction |
| Input: Whole wheat | 100 | 62 | 6,200 | [3] 53 | [3] 5,300 |
| Output: | | | | | |
| Patent flour | 58 | 12 | 696 | 9 | 522 |
| 1st and 2d clear | 14 | 28 | 392 | 17 | 238 |
| Germ and shorts | 17 | 133 | 2,261 | 143 | 2,431 |
| Bran | 11 | 231 | 2,541 | 163 | 1,793 |
| Output total | 100 | | 5,890 | | 4,984 |
| Difference (input-output) | | | 310 | | 316 |
| Percent difference | | | 5.0 | | 6.0 |

[1] Production weighted average of 9 States.
[2] Production weighted average of 5 States.
[3] Production weighted average of 15 States.

FIGURE 4.—STRONTIUM 90 IN 1959 WHEAT AND MILLING PRODUCTS




## Tri-City Diet Study

*Health and Safety Laboratory, U.S. Atomic Energy Commission*

The Health and Safety Laboratory is conducting a survey of the strontium 90 and stable calcium levels of diets of persons living in New York City, San Francisco, and Chicago. Selected foods representing 19 food categories are purchased at each of these cities every 3 months and are analyzed for strontium 90 and stable calcium.

Using data from the U.S. Department of Agriculture "Household Food Survey" of 1955, the annual food consumption by an individual can be grouped into the same 19 categories, and the annual intake of strontium 90 and calcium can then be determined by summing the contributions from each category. Some food types are taken to be representative of larger food categories, as liquid milk for dairy products in general. Hence, in the tables that follow, the values shown for food consumption may not be directly related to the original data in the source document.

Tables 3, 4, and 5 show the results obtained for the three cities on the first completed set of analyses.[5]

[5] Data from *Quarterly Summary Report*, HASL-105, Jan. 9, 1961.

TABLE 3.—STRONTIUM 90 AND CALCIUM LEVELS OF DIET

*New York City, March 1960*

| Food type | Annual consumption (kg/yr) | Calcium | | Strontium 90 | | | Food type | Annual consumption (kg/yr) | Calcium | | Strontium 90 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | gm/kg original material | gm/year | μμc/kg original material | μμc/gm Ca | μμc/year | | | gm/kg original material | gm/year | μμc/kg original material | μμc/gm Ca | μμc/year |
| Whole grain products | 11 | 0.68 | 7.5 | 20.7 | 30.4 | 228 | Fruit: | | | | | | |
| Refined grain products | 37 | .74 | 27.3 | 9.5 | 12.9 | 352 | Canned | 26 | .05 | 1.3 | 1.5 | 29.3 | 39 |
| Refined grain flour | 43 | .21 | 9.2 | 10.4 | 48.6 | 447 | Fresh | 68 | .16 | 10.7 | .3 | 2.1 | 20 |
| Milk, liquid | 221 | 1.05 | 232.1 | 9.5 | 9.1 | 2,100 | Juices | 19 | .09 | 1.7 | 1.5 | 16.6 | 29 |
| Potatoes | 45 | .08 | 3.4 | 9.8 | 129.3 | 441 | Rice | 3 | .49 | 1.3 | 1.3 | 2.6 | 7 |
| Macaroni | 3 | .23 | .7 | 7.2 | 31.8 | 22 | Eggs | 16 | 1.78 | 28.5 | 10.6 | 5.9 | 170 |
| Beans, dried | 3 | .59 | 1.6 | 2.1 | 3.6 | 6 | Fish: | | | | | | |
| Vegetables: | | | | | | | Fresh | 8 | 1.61 | 12.9 | .3 | .2 | 2 |
| Canned | 20 | .14 | 2.9 | 4.2 | 29.4 | 84 | Shell | 1 | 1.34 | 1.9 | 1.8 | 1.3 | 2 |
| Fresh | 43 | .47 | 20.0 | 5.5 | 11.9 | 237 | Meat | 72 | .09 | 6.5 | 1.0 | 11.2 | 72 |
| Root | 17 | .57 | 9.6 | 5.3 | 9.3 | 90 | Poultry | 17 | .36 | 6.1 | 1.6 | 4.5 | 27 |
| | | | | | | | Total | | | 385.2 | | | 4,375 |

Averages: 11.4 μμc $Sr^{90}$/gm Ca; 12.0 μμc $Sr^{90}$/day.

TABLE 4.—STRONTIUM 90 AND CALCIUM LEVELS OF DIET

*San Francisco, March 1960*

| Food type | Annual consumption (kg/yr) | Calcium | | Strontium 90 | | | Food type | Annual consumption (kg/yr) | Calcium | | Strontium 90 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | gm/kg original material | gm/year | μμc/kg original material | μμc/gm Ca | μμc/year | | | gm/kg original material | gm/year | μμc/kg original material | μμc/gm Ca | μμc/year |
| Whole grain products | 11 | 0.93 | 10.2 | 2.9 | 3.1 | 32 | Fruit: | | | | | | |
| Refined grain products | 37 | .81 | 30.1 | 2.6 | 3.1 | 95 | Canned | 26 | 0.05 | 1.4 | 1.4 | 25.9 | 37 |
| Refined grain flour | 43 | .20 | 8.4 | 3.6 | 18.6 | 156 | Juices | 19 | .08 | 1.6 | 2.4 | 28.1 | 45 |
| Milk, liquid | 221 | 1.05 | 232.1 | 4.2 | 4.0 | 928 | Fresh | 68 | .31 | 20.8 | .7 | 2.3 | 46 |
| Potatoes | 45 | .16 | 7.0 | 4.4 | 28.2 | 198 | Rice | 3 | .30 | .8 | 1.8 | 6.1 | 5 |
| Macaroni | 3 | .20 | .6 | 3.7 | 19.6 | 11 | Eggs | 16 | .65 | 10.4 | 2.9 | 4.5 | 47 |
| Beans, dried | 3 | 1.05 | 2.8 | 6.9 | 6.6 | 19 | Fish: | | | | | | |
| Vegetables: | | | | | | | Fresh | 8 | 1.24 | 9.9 | .2 | .2 | 2 |
| Canned | 20 | .25 | 5.0 | 1.8 | 7.4 | 37 | Shell | 1 | .79 | 1.1 | .5 | .6 | 1 |
| Fresh | 43 | .27 | 11.5 | 2.3 | 8.5 | 98 | Meat | 72 | .14 | 10.1 | 1.9 | 14.4 | 137 |
| Root | 17 | .41 | 6.9 | 5.8 | 14.2 | 98 | Poultry | 17 | .32 | 5.4 | .7 | 2.3 | 13 |
| | | | | | | | Total | | | 376.1 | | | 2,005 |

Averages: 5.3 μμc $Sr^{90}$/gm Ca; 5.5 μμc $Sr^{90}$/day.

TABLE 5.—STRONTIUM 90 AND CALCIUM LEVELS OF DIET

*Chicago, May 1960*

| Food type | Annual consumption (kg/yr) | Calcium | | Strontium 90 | | | Food type | Annual consumption (kg/yr) | Calcium | | Strontium 90 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | gm/kg original material | gm/year | μμc/kg original material | μμc/gm Ca | μμc/year | | | gm/kg original material | gm/year | μμc/kg original material | μμc/gm Ca | μμc/year |
| Whole grain products | 11 | 0.85 | 9.4 | 19.9 | 23.4 | 219 | Fruit: | | | | | | |
| Refined grain products | 37 | .92 | 34.0 | 13.1 | 14.2 | 485 | Canned | 26 | 0.05 | 1.3 | 1.9 | 38.2 | 49 |
| Refined grain flour | 43 | .20 | 8.6 | 11.3 | 55.2 | 486 | Juices | 19 | .08 | 1.5 | 3.5 | 44.8 | 67 |
| Milk, liquid | 221 | .99 | 218.8 | 6.1 | 6.2 | 1,348 | Fresh | 68 | .21 | 14.3 | 6.0 | 27.6 | 408 |
| Potatoes | 45 | .14 | 6.3 | 2.9 | 21.2 | 131 | Rice | 3 | .19 | .6 | 1.8 | 9.5 | 5 |
| Macaroni | 3 | .22 | .7 | 9.8 | 43.7 | 29 | Eggs | 16 | .54 | 8.6 | 3.2 | 5.9 | 51 |
| Beans, dried | 3 | 1.45 | 4.4 | 1.8 | 12.0 | 5 | Fish: | | | | | | |
| Vegetables: | | | | | | | Fresh | 8 | 1.55 | 12.4 | 1.0 | .6 | 8 |
| Canned | 20 | .20 | 4.0 | 4.7 | 23.8 | 94 | Shell | 1 | .50 | .5 | .7 | 1.5 | 1 |
| Fresh | 43 | .36 | 15.5 | 11.1 | 31.0 | 474 | Meat | 72 | .09 | 6.5 | 1.0 | 11.9 | 72 |
| Root | 17 | .38 | 6.5 | 6.8 | 17.8 | 116 | Poultry | 17 | .79 | 13.4 | 1.3 | 1.6 | 22 |
| | | | | | | | Total | | | 367.3 | | | 4,073 |

Averages: 11.1 μμc $Sr^{90}$/gm Ca; 11.1 μμc $Sr^{90}$/day.

## Strontium 90 Concentration in Bread Purchased in New York City

*Health and Safety Laboratory, U.S. Atomic Energy Commission*

The following table presents data on the concentration of strontium 90 in bread purchased in New York City in July 1960. One loaf of each type was purchased daily from a local grocery and the loaves composited on a monthly basis. Five different brands are represented in each month's sample. Previous results were reported in *Radiological Health Data*, Volume I, Nos. 7 and 9.

TABLE 6.—STRONTIUM 90 AND CALCIUM IN BREAD PURCHASED IN NEW YORK CITY,[1] JULY 1960

| Type of Bread | Calcium | Strontium 90 | | |
|---|---|---|---|---|
| | gm/kg of original material | μμc/gm Ca | μμc/kg of original material | μμc/daily intake [2] |
| Wholewheat | 0.82 | 33 | 27 | 0.10 |
| White | .66 | 18 | 12 | .45 |

[1] Data taken from *Quarterly Summary Report*, HASL-105, Jan 9, 1961.
[2] Calculated values from U.S. Department of Agriculure data on average daily per capita consumption of 3.6 gm/day of wholewheat bread and 46.2 gm/day of white bread (see *Radiological Health Data*, Vol. I, No. 5).

## Strontium 90 Concentration in Breakfast Cereals Purchased in New York City

*Health and Safety Laboratory, U.S. Atomic Energy Commission*

The following table shows the results of analyses of breakfast cereals containing wheat or bran, purchased in New York City during April 1960. These data may be compared with the results obtained by the Public Health Service's Robert A. Taft Sanitary Engineering Center for cereal purchased in Cincinnati, Ohio, April 1960. These were published in *Radiological Health Data*, Volume 1, No. 4.

TABLE 7.—STRONTIUM 90 CONCENTRATION IN BREAKFAST CEREALS [1]

*New York City, April 1960*

| Type of cereal | Brand | Strontium 90 | |
|---|---|---|---|
| | | μμc/gm calcium | μμc/kg |
| 100 percent bran | 1 | 105 | 95 |
| | 2 | 89 | 85 |
| | 2 | 85 | 81 |
| 40 percent bran | 3 | 85 | 53 |
| Wholewheat | 1 | 72 | 53 |
| | 3 | 70 | 30 |
| | 4 | 62 | 29 |
| | 5 | 73 | 32 |
| Wholewheat (enriched): | | | |
| Regular | 5 | 60 | 31 |
| Instant | 5 | 41 | 21 |

[1] Reported in *Quarterly Summary Report*, HASL-105, Jan. 9, 1961.

## Strontium 90 in Foreign Wheat Samples

*Health and Safety Laboratory, U.S. Atomic Energy Commission*

As part of the continuing effort of the Health and Safety Laboratory to document the extent and effects of worldwide fallout, samples of wheat grown in various countries have been obtained and analyzed for strontium 90 and calcium. The preliminary results of this investigation are reported in table 8.[1]

The variability in the strontium 90 content of wheat samples obtained from the same country is apparent. Because of this variability, it is difficult to assess the representativeness of a single sample or small group of samples from a given region, and generalizations from these data must therefore be regarded cautiously.

[1] Data from *Quarterly Summary Report*, HASL-105, Jan. 9, 1961.



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TABLE 8.—STRONTIUM 90 AND CALCIUM CONTENT OF FOREIGN WHEAT SAMPLES GROWN IN 1959

| Region of origin | Number of samples | Approximate harvest period | Calcium | | | | Strontium 90 | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | gm/kg original material | | | | μμc/gm Ca | | | | μμc/kg original material | | | |
| | | | Mean | Standard deviation | Minimum | Maximum | Mean | Standard deviation | Minimum | Maximum | Mean | Standard deviation | Minimum | Maximum |
| Argentina | 14 | November 1959–January 1960. | 0.53 | 0.08 | 0.35 | 0.62 | 31 | 9 | 21 | 48 | 16 | 4 | 12 | 23 |
| Australia | 1 | do | .35 | | | | 32 | | | | 11 | | | |
| France | 9 | June–August | .39 | .03 | .32 | .42 | 53 | 15 | 29 | 85 | 20 | 5 | 12 | 32 |
| Germany | 1 | July–August | .44 | | | | 75 | | | | 33 | | | |
| Greece | 2 | Not known | .45 | .05 | .40 | .50 | 70 | 19 | 60 | 98 | 35 | 5 | 30 | 40 |
| Manchuria | 1 | do | .41 | | | | 155 | | | | 64 | | | |
| Russia | 12 | July–September | .47 | .07 | .41 | .67 | 83 | 44 | 42 | 220 | 39 | 19 | 18 | 54 |

# SECTION III.—MILK

## Milk Monitoring Program

*Division of Radiological Health, Public Health Service*

The original Public Health Service milk monitoring program consisted of 12 sampling stations, of which 9 are still active. Raw milk is spot sampled at these stations. During 1960 a new sampling program of about 60 stations was established. Processed milk is sampled at these stations. Since the sampling procedures for the raw milk sampling stations and the processed milk area sampling stations are different, they are described and reported separately. The Public Health Service Robert A. Taft Sanitary Engineering Center, Cincinnati, Ohio, continues to conduct the analyses for the original network stations; the Public Health Service Southeastern Radiological Health Laboratory at Montgomery, Ala., and the Southwestern Radiological Health Laboratory at Las Vegas, Nev., provide this service for the new program.

The purposes of the two sampling programs are not the same. The original network was established to develop sampling and radiochemical analytical proficiencies under conditions which would remain similar over a period of time in regard to the source of milk. During the operation of this program it became apparent that a broader sampling program, more directly related to the milk consumed by the population, was necessary. The Public Health Service and the Department of Health, Education, and Welfare acted to provide facilities for this change. This resulted in the transition from the program of sampling raw milk, collected from milksheds of limited size, to a sampling program designed to be representative of the processed milk consumed in a given municipality.

In some instances, the newly designated stations are the same as those which were reported originally. The establishment of the new processed-milk area sampling stations does not preclude the need for further raw-milk sampling from the selected milkshed serving the same city. It is important that both networks be in operation for a sufficient period of time to provide an overlap for the purpose of comparative study.

Because of the different sources of these samples, changes in the collecting system, and the utilization of different laboratory techniques, differences were anticipated in the amounts of radioactivity found in the milk under the two programs. For this reason, an investigation to determine the comparability of the two programs was begun in January 1961. This investigation covers many factors, including laboratory methodology and collecting methods. Until this study has been completed and additional experience has been gained under the new program, no valid interpretation can be made of any differences of radioactivity in milk samples collected under the two systems.

Publication of the data will normally follow about 4 months after collection of samples because of the time required for shipment, processing, decay product buildup, compilation of the data, clearance and publication procedures.

## *Raw-Milk Sampling Stations*

The initial purpose of establishing this network was in keeping with the normal and continuing program of the Public Health Service to determine trends in our changing environment with respect to measuring the amount of radioactivity in water, air, milk, and other foods. Milk was the food chosen for initial testing because it is among the most important components of the diet and is available at all seasons of the year and in all climates. A primary objective of the project was to develop effective collection systems and radiochemical analysis procedures to make them more suitable for larger scale programs.

The criteria on which the selection of the original sampling stations was based appeared in the discussion sections of all volume I issues of *Radiological Health Data*.

One-gallon raw-milk samples are collected once each month and forwarded by air parcel post to the Robert A. Taft Sanitary Engineering Center for radionuclide analysis. It is estimated that these samples represent 2,000-gallon lots. The concentration of iodine 131, barium 140, cesium 137, and naturally occurring potassium 40 are all currently being measured by gamma scintillation spectroscopy. Total radiostrontium and strontium 90 are determined following radiochemical separations. The amount of strontium 90 is calculated by measuring the buildup of the strontium 90 daughter decay product, yttrium 90 over a 2-week period. Measurements are made in a low background anticoincidence beta counter. The total radioactive strontium is counted in a shielded internal proportional counter, with the strontium 89 calculated as the difference between this value and strontium 90. Stable calcium is also determined.

April through September 1960 issues of *Radiological Health Data* list references for technical descriptions of the methodology of analyses used.

November data for the raw-milk-sampling stations are presented in table 1.

## *Processed Milk Area Sampling Stations*

The monitoring of milk has been expanded to provide additional information on levels of radioactivity in milk consumed by the public. The new stations have been established in cooperation with State and local health and milk sanitation agencies. Each city has been selected to provide adequate coverage with respect to production areas and the consuming population. The emphases of this expanded sampling and radioassay program are—

1. Measuring the radioactivity levels of the milk consumed by the public in various regions of the country by obtaining samples of pasteurized and homogenized milk at the processing plant; and

2. Providing one sampling point within each State with additional points when indicated by widely varying conditions of the milk supply or the need to provide coverage of large population groups. This differs from the original set of sampling stations whose selection was based principally upon certain criteria involving the milk production and milkshed area characteristics.

The new network was designed to sample processed milk rather than the raw product. The sampling procedure was developed to provide a sample from one day's sales per month in a community which will be as representative of the total supply as can be achieved under practical conditions. The sample will be a composite of those plants supplying not less than 90 percent of the

TABLE 1.—RADIOACTIVITY IN MILK

*Robert A. Taft Sanitary Engineering Center, Raw-Milk-Sampling Stations, November 1960*

[Radioactivity in μμc/liter]

| Area | Calcium (grams/liter) | | Iodine 131 | | Strontium 89 | | Strontium 90 | | Barium 140 | | Cesium 137 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | November | Yearly average | November | Yearly average | November | Yearly average | November | Yearly average | November | Yearly average | November | Yearly average |
| Atlanta, Ga. | 1.20 | 1.13 | ND[1] | <10 | ND | <5 | 12.5 | 14.8 | ND | <10 | 20 | 40 |
| Austin, Tex. | 1.14 | 1.11 | ND | <10 | ND | <5 | 4.0 | 4.5 | ND | <10 | 5 | 15 |
| Chicago, Ill. | 1.19 | 1.10 | ND | <10 | ND | <5 | 7.7 | 9.4 | ND | <10 | 15 | 30 |
| Cincinnati, Ohio | 1.21 | 1.13 | ND | <10 | ND | <5 | 8.8 | 10.5 | ND | <10 | 15 | 25 |
| New York, N.Y. | 1.20 | 1.09 | ND | <10 | ND | <5 | 9.0 | 9.5 | ND | <10 | 20 | 30 |
| Sacramento, Calif. | 1.21 | 1.12 | ND | <10 | ND | <5 | 2.7 | 3.5 | ND | <10 | 10 | 10 |
| Salt Lake City, Utah | 1.22 | 1.11 | ND | <10 | ND | <5 | 3.4 | 6.2 | ND | <10 | 10 | 30 |
| Spokane, Wash. | 1.27 | 1.12 | ND | <10 | ND | <5 | 6.8 | 11.7 | ND | <10 | 20 | 40 |
| St. Louis, Mo. | 1.27 | 1.21 | ND | <10 | ND | <5 | 13.7 | 18.7 | ND | <10 | 25 | 30 |

[1] NC—No detectable activity.

city's milk supply. The contribution from each plant to the total sample is intended to be approximately proportional to volume of milk sold.

The samples from the new stations are collected with the assistance of the various State and local health and milk sanitation agencies and are shipped for analysis to either the Southwestern or Southeastern Radiological Health Laboratory. The Southeastern Radiological Health Laboratory processes samples from the 30 States generally east of the Mississippi, and the Southwestern Radiological Health Laboratory processes samples from the Western States.

At the present time radioassays for $Sr^{89}$, $Sr^{90}$, $Cs^{137}$, $Ba^{140}$, and $I^{131}$ are being performed. To date, the latter two isotopes have been below present limits of detection. Other radionuclides of concern to public health agencies will be included for assay as necessary for complete monitoring of the milk supply.

November data from the two laboratories are presented in table 2.

TABLE 2.—RADIOACTIVITY IN MILK

*Processed Milk Area Sampling Stations, November 1960*

[Radioactivity in $\mu\mu c$/liter]

| Area | Calcium (grams/liter) | | Strontium 89 | | Strontium 90 | | Cesium 137 | |
|---|---|---|---|---|---|---|---|---|
| | November | Average to date | November | Average to date | November | Average to date | November | Average to date |
| Albuquerque, N. Mex. | 1.00 | 1.10 | ND[1] | <5 | 4 | 4 | 10 | 5 |
| Atlanta, Ga. | 1.25 | 1.23 | ND | <5 | 8 | 10 | ND | <5 |
| Austin, Tex. | 1.26 | 1.16 | ND | <5 | 1 | 2 | ND | 5 |
| Baltimore, Md. | 1.26 | 1.16 | ND | <5 | 7 | 7 | ND | <5 |
| Boston, Mass. | 1.19 | 1.19 | ND | <5 | 11 | 12 | 5 | 15 |
| Buffalo, N.Y. | 1.15 | 1.16 | ND | <5 | 6 | 7 | ND | 5 |
| Burlington, Vt. | 1.20 | 1.20 | ND | <5 | 7 | 9 | ND | 10 |
| Charleston, S.C. | 1.27 | 1.23 | ND | <5 | 8 | 10 | ND | 5 |
| Charleston, W. Va. | 1.21 | 1.17 | ND | <5 | 7 | 9 | ND | <5 |
| Charlotte, N.C. | 1.30 | 1.22 | ND | <5 | 10 | 12 | ND | 5 |
| Chattanooga, Tenn. | 1.32 | 1.30 | ND | <5 | 10 | 11 | ND | <5 |
| Chicago, Ill. | 1.22 | 1.14 | ND | <5 | 6 | 6 | ND | <5 |
| Cincinnati, Ohio | 1.12 | 1.16 | ND | <5 | 8 | 8 | ND | <5 |
| Cleveland, Ohio | 1.23 | 1.15 | ND | <5 | 7 | 8 | ND | <5 |
| Dallas, Tex. | 1.07 | 1.20 | ND | <5 | 5 | 6 | ND | <5 |
| Denver, Colo. | 1.01 | 1.09 | ND | <5 | 5 | 6 | 15 | 15 |
| Detroit, Mich. | 1.19 | 1.16 | ND | <5 | 8 | 7 | ND | <5 |
| Des Moines, Iowa | 1.00 | 1.04 | ND | <5 | 8 | 8 | 10 | 15 |
| Grand Rapids, Mich. | 1.26 | 1.23 | ND | <5 | 7 | 8 | ND | <5 |
| Hartford, Conn. | 1.35 | 1.19 | ND | <5 | 10 | 9 | ND | 10 |
| Helena, Mont. | 1.10 | 1.06 | ND | <5 | 6 | 7 | 10 | 10 |
| Honolulu, Hawaii | 1.00 | 1.05 | ND | <5 | 4 | 5 | 10 | 30 |
| Idaho Falls, Idaho | 1.06 | 1.06 | ND | <5 | 5 | 5 | 10 | 20 |
| Indianapolis, Ind. | 1.32 | 1.20 | ND | <5 | 6 | 6 | ND | <5 |
| Jackson, Miss. | 1.40 | 1.30 | ND | <5 | 10 | 11 | ND | <5 |
| Kansas City, Mo. | 1.04 | 1.06 | ND | <5 | 8 | 8 | 20 | 15 |
| Laramie, Wyo. | 1.08 | 1.05 | ND | <5 | 5 | 5 | 10 | 5 |
| Las Vegas, Nev. | 1.08 | 1.05 | ND | <5 | 2 | 2 | ND | <5 |
| Little Rock, Ark. | 1.20 | 1.21 | ND | <5 | 14 | 13 | ND | <5 |
| Louisville, Ky. | 1.23 | 1.19 | ND | <5 | 10 | 9 | ND | <5 |
| Manchester, N.H. | 1.23 | 1.22 | ND | <5 | 10 | 12 | 15 | 30 |
| Memphis, Tenn. | 1.31 | 1.25 | ND | <5 | 8 | 11 | ND | <5 |
| Milwaukee, Wis. | 1.20 | 1.16 | ND | <5 | 7 | 6 | ND | <5 |
| Minneapolis, Minn. | 1.02 | 1.03 | ND | <5 | 7 | 8 | 5 | <5 |
| New Orleans, La. | 1.29 | 1.26 | ND | <5 | 10 | 14 | ND | <5 |
| New York, N.Y. | 1.20 | 1.13 | ND | <5 | 10 | 9 | ND | 5 |
| Norfolk, Va. | 1.22 | 1.19 | ND | <5 | 8 | 9 | ND | <5 |
| Oklahoma City, Okla. | 1.23 | 1.18 | ND | <5 | 6 | 8 | ND | <5 |
| Omaha, Nebr. | 1.02 | 1.04 | ND | <5 | 7 | 7 | 10 | 5 |
| Palmer, Alaska | 1.03 | 1.07 | ND | <5 | 8 | 7 | 5 | 10 |
| Philadelphia, Pa. | 1.22 | 1.16 | ND | <5 | 6 | 8 | ND | 10 |
| Phoenix, Ariz. | .98 | 1.00 | ND | <5 | 4 | 4 | 10 | 20 |
| Pittsburgh, Pa. | 1.24 | 1.21 | ND | <5 | 10 | 12 | ND | 10 |
| Portland, Maine | 1.09 | 1.13 | ND | <5 | 9 | 11 | ND | 20 |
| Portland, Oreg. | 1.08 | 1.10 | ND | <5 | 8 | 10 | 25 | 40 |
| Providence, R.I. | 1.23 | 1.18 | ND | <5 | 9 | 12 | ND | 10 |
| Sacramento, Calif. | 1.07 | 1.04 | ND | <5 | 3 | 4 | 5 | <5 |
| Salt Lake City, Utah | 1.12 | 1.09 | ND | <5 | 5 | 6 | 10 | 5 |
| San Francisco, Calif. | 1.12 | 1.10 | ND | <5 | 3 | 4 | 10 | 10 |
| San Juan, P.R. | 1.18 | 1.15 | ND | <5 | 4 | 4 | ND | <5 |
| Seattle, Wash. | 1.03 | 1.07 | ND | <5 | 6 | 8 | 25 | 40 |
| Spokane, Wash. | 1.13 | 1.07 | ND | <5 | 7 | 7 | 20 | 25 |
| St. George, Utah | 1.09 | 1.03 | ND | <5 | 5 | 5 | 10 | 5 |
| St. Louis, Mo. | 1.02 | 1.04 | ND | <5 | 7 | 6 | 35 | 40 |
| Syracuse, N.Y. | 1.22 | 1.22 | ND | <5 | 8 | 7 | ND | 10 |
| Tampa, Fla. | 1.29 | 1.25 | ND | <5 | 5 | 5 | 80 | 80 |
| Trenton, N.J. | 1.19 | 1.18 | ND | <5 | 10 | 8 | ND | 5 |
| Washington, D.C. | 1.20 | 1.14 | ND | <5 | 11 | 8 | ND | <5 |
| Wichita, Kans. | 1.10 | 1.07 | ND | <5 | 6 | 6 | 5 | <5 |
| Wilmington, Del. | 1.21 | 1.20 | ND | <5 | 8 | 8 | ND | 10 |

[1] ND—No detectable activity.

Because this program was initiated in 1960 and sampling stations necessarily became operative in a staggered sequence, the averages shown represent all samples taken to date. Averages will normally be for the latest 12-month period after sampling began. For the November data, the averages cover a period of three to nine months.

## *Strontium 90 in Canadian Dried-Milk Products*

The following table presents the results of measurements of strontium 90 in Canadian dried milk for the months of July, August, and September, 1960. This table was included in the "Quarterly Report of the Radioactive Fallout Study Program," dated December 1960, published by the Radiation Protection Division of the Department of National Health and Welfare, Ottawa, Canada. Figure 5 shows the sampling locations.

Data for the previous months in 1960 were published in *Radiological Health Data*, volume 1, Nos. 6 and 9.

TABLE 3.—STRONTIUM 90 CONTENT OF CANADIAN DRIED MILK POWDER SAMPLES

[Concentrations in $\mu\mu c$/gm calcium]

| Station | July 1960 | August 1960 | September 1960 | Station | July 1960 | August 1960 | September 1960 |
|---|---|---|---|---|---|---|---|
| Calgary | 9.4 | 8.2 | 8.8 | Moncton [1,3] | 7.9 | 12.0 | 9.6 |
| Charlottetown | [2] NS | NS | NS | Ottawa [1] | 5.5 | 3.7 | 3.8 |
| Chicoutimi | NS | 13.2 | 10.4 | Saskatoon [3] | 6.5 | 6.4 | 5.8 |
| East Florenceville | 12.1 | 14.0 | 10.6 | Sussex | 11.4 | 11.6 | 9.0 |
| Edmonton [1] | 10.4 | 7.8 | 7.5 | Vancouver [1] | 11.9 | 9.7 | 9.0 |
| Granby [1] | 18.3 | 12.3 | 10.3 | Walkerton | 4.7 | 3.4 | 3.3 |
| La Durantye | 18.6 | 11.5 | 10.2 | Winnipeg [3] | 6.7 | 5.8 | 6.3 |
| London [1] | 4.8 | 3.8 | 3.4 | | | | |
| Magantic | 17.6 | 16.7 | 13.6 | Average | 10.4 | 9.3 | 8.1 |

[1] Natural strontium determinations made for these stations. All other stations were corrected for natural strontium using an average factor of 1.06.
[2] Buttermilk sample. All other samples are skim milk.
[3] NS=No milk powder manufactured for the month.
Samples collected by Inspectors of the Marketing Division, Department of Agriculture.

FIGURE 5.—MILK SAMPLING STATIONS IN CANADA

# SECTION IV.—WATER

## National Water Quality Network

*Division of Water Supply and Pollution Control, Public Health Service*

The National Water Quality Network was established under the provision of section 4(c) of Public Law 660, which states "* * * The Surgeon General shall * * * collect and disseminate basic data * * * [relating] to water pollution and the prevention and control thereof."

This network, operated in cooperation with State and local health agencies, was started in October 1957. At present there are 75 sampling stations located on major waterways used for public water supply, propagation of fish and wildlife, recreational purposes, and for agricultural, industrial and other uses; some of these stations are on interstate, coastal, and international boundary waters, and waters on which activities of the Federal Government may have an impact. Ultimately a total of 250 to 300 stations will be in operation. A few of the more recently established stations have not begun to report radioactivity.

Samples of water are examined for chemical, physical, and biological quality insofar as these relate to pollution. Samples for some determinations are taken weekly, others monthly, and for some, continuous composite samples of 10 to 15 days are obtained.

Gross alpha and beta measurements are made on both suspended and dissolved solids in the raw surface water samples. The radioactivity levels of dissolved solids provide a rough measure of the levels which may be found in a treated water, where such water treatment removes substantially all of the suspended matter. Naturally occurring radioactive substances in the environment are the source of essentially all of the alpha activity. The contamination of the environment from manmade sources is the major contributor to the beta activity. It should be noted that with the cessation of weapons testing, beta activity in most raw waters is generally approaching a level attributable solely to natural beta activity. Natural beta activity can be two or three times the natural alpha activity based on the presence of the same nuclides. Some exceptions to this are seen, notably the data for the Columbia River and the Animas River. The results are reported in micromicrocuries per liter, and are shown for each station on a given river.

While beta determinations for the first 2 years of the network operation have been conducted on each sample weekly, the alpha determinations are reported generally on a composite sample of more than 1 week. Beginning with samples taken in January 1960, beta determinations were performed on composite samples obtained by combining two weekly samples. The alpha data will be reported on 3-month composite samples, with one-third of the stations being covered each month. All the data reported in table 1 represent the average of all information available for the month indicated.

Strontium 90 data reported are the results of determinations on composite samples for a 3-month period ending in the month shown.

FIGURE 6.—PUBLIC HEALTH SERVICE NATIONAL WATER QUALITY NETWORK SAMPLING STATIONS

As of June 30, 1960

Additional information and data may be obtained from the following sources:

*National Water Quality Network Annual Compilation of Data*, PHS Publication. For sale by the Superintendent of Documents, U.S. Government Printing Office, Washington 25, D.C. Price, $1.50.

*Report on National Water Quality Control Network* submitted by Dr. F. J. Weber, Chief, Division of Radiological Health, PHS, at the Joint Committee on Atomic Energy "Hearings on Fallout From Nuclear Weapons Tests," volume 1, May 1959, pages 167–169.

TABLE 1.—RADIOACTIVITY IN RAW SURFACE WATERS

[Concentrations in μμc/liter]

| Station | Quarter ending Oct. 30, 1960 | October 1960 | | | | | |
|---|---|---|---|---|---|---|---|
| | Strontium 90 | Beta activity | | | Alpha activity | | |
| | | Suspended | Dissolved | Total | Suspended | Dissolved | Total |
| Animas River: Cedar Hill, N. Mex. | 0.4 | 26 | 40 | 66 | 2 | 20 | 22 |
| Apalachicola River: Chattahoochie, Fla. | .5 | 0 | 0 | 0 | 0 | 2 | 2 |
| Arkansas River: | | | | | | | |
| Coolidge, Kans. | .8 | 0 | 0 | 0 | 3 | 63 | 66 |
| Ponca City, Okla. | | 0 | 0 | 0 | 7 | 3 | 10 |
| Pendleton Ferry, Ark. | | 1 | 20 | 21 | 7 | 2 | 9 |
| Chattahoochie River: | | | | | | | |
| Atlanta, Ga. | | 0 | 2 | 2 | 0 | 1 | 1 |
| Columbus, Ga. | | 0 | 0 | 0 | 0 | 1 | 1 |
| Colorado River: | | | | | | | |
| Loma, Colo. | | 5 | 20 | 25 | 1 | 25 | 26 |
| Page, Ariz. | | 114 | 2 | 116 | 55 | 23 | 78 |
| Hoover Dam, Ariz.—Nev. | 1.0 | 0 | 0 | 0 | 0 | 10 | 10 |
| Parker Dam, Ariz.—Nev. | | 0 | 1 | 1 | 0 | 17 | 17 |
| Yuma, Ariz. | | 0 | 3 | 3 | <1 | 2 | 3 |
| Columbia River: | | | | | | | |
| Pasco, Wash. | | 66 | 651 | 717 | 0 | 2 | 2 |
| Wenatchee, Wash. | | 0 | 0 | 0 | 0 | 2 | 2 |
| Bonneville Dam, Oreg. | | 11 | 262 | 273 | 0 | 2 | 2 |
| Clatskanie, Oreg. | .3 | 8 | 140 | 148 | 0 | 1 | 1 |
| Connecticut River: Northfield, Mass. | | 0 | 0 | 0 | 0 | 1 | 1 |

TABLE 1.—RADIOACTIVITY IN RAW SURFACE WATERS—Continued

[Concentrations in μμc/liter]

| Station | Quarter ending Oct. 30, 1960 | October 1960 | | | | | |
|---|---|---|---|---|---|---|---|
| | Strontium 90 | Beta activity | | | Alpha activity | | |
| | | Suspended | Dissolved | Total | Suspended | Dissolved | Total |
| Delaware River: | | | | | | | |
| Martin's Creek, Pa. | | 0 | 1 | 1 | 0 | 1 | 1 |
| Philadelphia, Pa. | | 0 | 0 | 0 | 2 | 0 | 2 |
| Escambia River: Century, Fla. | | 0 | 0 | 0 | 0 | 1 | 1 |
| Great Lakes: | | | | | | | |
| Gary, Ind. | 0.5 | 0 | 4 | 4 | 0 | 3 | 3 |
| Duluth, Minn. | | 0 | 0 | 0 | 0 | 1 | 1 |
| Milwaukee, Wis. | | 0 | 0 | 0 | 0 | <1 | <1 |
| Hudson River: Poughkeepsie, N.Y. | .1 | 0 | 2 | 2 | 0 | 2 | 2 |
| Illinois River: Peoria, Ill. | .3 | 2 | 2 | 4 | 1 | 2 | 3 |
| Kanawha River: Winfield Dam, W. Va. | | 5 | 3 | 8 | | | |
| Little Miami River: Cincinnati, Ohio | | 2 | 0 | 2 | 0 | 4 | 4 |
| Mississippi River: | | | | | | | |
| Williston, N.Dak. | | 0 | 7 | 7 | 3 | 9 | 12 |
| Yankton, S.Dak. | .8 | 0 | 0 | 0 | 0 | 0 | 0 |
| Omaha, Nebr. | | 0 | 37 | 37 | 2 | 7 | 9 |
| St. Joseph, Mo. | | 28 | <1 | 28 | 12 | 7 | 19 |
| Kansas City, Kans. | | 1 | 0 | 1 | 2 | 5 | 7 |
| St. Louis, Mo. | 1.2 | 1 | 11 | 12 | 0 | 0 | 0 |
| Ohio River: | | | | | | | |
| East Liverpool, Ohio | .4 | 0 | 0 | 0 | 0 | 0 | 0 |
| Wheeling, W Va. | .5 | 0 | <1 | <1 | 0 | 2 | 2 |
| Huntington, W. Va. | | 0 | 0 | 0 | 0 | 0 | 0 |
| Cincinnati, Ohio | | 0 | 0 | 0 | 0 | 1 | 1 |
| Evansville, Ind. | | 0 | 0 | 0 | 0 | 2 | 2 |
| Cairo, Ill. | .4 | 2 | 23 | 25 | | | |
| Potomac River: Great Falls, Md. | | 0 | 0 | 0 | 0 | 4 | 4 |
| Red River, North: Grand Forks, N.Dak. | (1) | 0 | 5 | 5 | 1 | 4 | 5 |
| Red River, South: | | | | | | | |
| Denison, Tex. | | 0 | 0 | 0 | 0 | 11 | 11 |
| Index, Ark. | | 0 | 0 | 0 | 12 | 7 | 19 |
| Alexandria, La. | 1.1 | 0 | 0 | 0 | 2 | 6 | 8 |
| Rio Grande River: | | | | | | | |
| El Paso, Tex. | | 0 | 2 | 2 | 0 | 14 | 14 |
| Brownsville, Tex. | .3 | 4 | 0 | 4 | 2 | 0 | 2 |
| Sabin River: Ruliff, Tex. | | 2 | 2 | 4 | 1 | 1 | 2 |
| St. Clair River: Port Huron Mich. | .6 | <1 | <1 | 1 | 0 | 1 | 1 |
| St. Lawrence River: Massena, N.Y. | | 0 | 2 | 2 | 0 | 2 | 2 |
| St. Mary's River: Sault Ste. Marie, Mich. | | 0 | 0 | 0 | 0 | 1 | 1 |
| Schuylkill River: Philadelphia, Pa. | | 0 | <1 | <1 | 0 | 1 | 1 |
| Savannah River: | | | | | | | |
| Port Wenworth, Ga. | .8 | 0 | 28 | 28 | | | |
| North Augusta, S.C. | | 0 | 0 | 0 | 0 | 1 | 1 |
| Snake River: | | | | | | | |
| Wawawai, Wash. | .5 | 0 | 0 | 0 | 0 | 4 | 4 |
| Weiser, Idaho | | 5 | 20 | 25 | 0 | 7 | 7 |
| Susquehanna River: | | | | | | | |
| Sayre, Pa. | .3 | 0 | 0 | 0 | 0 | <1 | <1 |
| Conowingo, Md. | .3 | 0 | <1 | <1 | <1 | 1 | 1 |
| Tennessee River: Chattanooga, Tenn. | .6 | 0 | 22 | 22 | 0 | <3 | <1 |
| Yellowstone River: Sidney, Mont. | | 0 | 0 | 0 | 8 | 11 | 19 |

[1] Insufficient sample for analysis.

## Strontium 90 in Tap Water

*Health and Safety Laboratory, Atomic Energy Commission*

The Atomic Energy Commission's Health and Safety Laboratory monitors the tap water for Richmond, Calif., and New York City for strontium 90 on a monthly basis. Data for the third quarter 1960 are presented below. Previous data for 1960 were given in *Radiological Health Data*, Volume I, Nos. 1, 5 and 9.

TABLE 2.—STRONTIUM 90 IN TAP WATER [1]

*Third Quarter 1960*

| Location | Month | Activity (μμc/liter) |
|---|---|---|
| Richmond, Calif. (40 liters per sample) | July | 0.245 |
| | August | .253 |
| | September | .247 |
| New York City (100-200 liters per sample) | July | .51 |
| | August | .46 |
| | September | .47 |

[1] Data from *Quarterly Summary Report*, HASL-105, dated Jan. 9, 1961.

# SECTION V.—OTHER DATA

## External Gamma Activity

*Division of Radiological Health,*
*Radiation Surveillance Network, Public Health Service*

Portable survey instruments are available at stations of the Radiation Surveillance Network for recording levels of external gamma radiation. Measurements are made daily approximately 3 feet above the ground. These readings are not precise, but are sufficiently accurate to illustrate any significant variations above background. The differences among the values shown in the following table are within the variance anticipated due to differences in normal background and in instrument response characteristics.

TABLE 1.—EXTERNAL GAMMA ACTIVITY

*November 1960*

| Station location | Average (mr/hr) | Station location | Average (mr/hr) | Station location | Average (mr/hr |
|---|---|---|---|---|---|
| Anchorage, Alaska | 0.01 | Iowa City, Iowa | 0.02 | Ponca City, Okla | 0.04 |
| Fairbanks Alaska | (1) | Topeka, Kans | (1) | Portland Oreg | .02 |
| Juneau, Alaska | .01 | New Orleans, La | .01 | Harrisburg, Pa | .01 |
| Phoenix, Ariz | .01 | Baltimore, Md | .02 | Providence R.I | .02 |
| Little Rock, Ark | .01 | Lawrence, Mass | .02 | Columbia, S.C | .02 |
| Berkeley, Calif | .01 | Lansing, Mich | .02 | Edgemont, S. Dak | (1) |
| Los Angeles, Calif | .01 | Minneapolis, Minn | .01 | Pierre, S. Dak | .02 |
| Denver, Colo | .02 | Pascagoula, Miss | (1) | Austin, Tex | .01 |
| Hartford, Conn | .01 | Jefferson City, Mo | .01 | El Paso, Tex | .02 |
| District of Columbia | .02 | Helena, Mont | .03 | Salt Lake City, Utah | .02 |
| Jacksonville, Fla | .02 | Trenton, N.J | (2) | Richmond, Va | .01 |
| Atlanta, Ga | .02 | Santa Fe, N. Mex | .04 | Seattle, Wash | .02 |
| Honolulu, Hawaii | .03 | Albany, N.Y | .02 | Cheyenne Wyo | .03 |
| Boise, Idaho | .02 | Gastonia, N.C | .02 | Madison, Wis | .02 |
| Springfield, Ill | (1) | Cincinnati, Ohio | (1) | | |
| Indianapolis, Ind | .01 | Oklahoma City, Okla | .02 | | |

[1] No data received. [2] Instrument failure.

## Cesium 137 Levels in Humans

*Walter Reed Army Institute of Research, Washington, D.C., and U.S. Army Medical Research Unit, Landstuhl, Germany*

Since July 1958, the Whole Body Counting Facility at the Walter Reed Army Institute of Research has been assaying people and foodstuffs for gamma radioactivity. A detailed report of the facility, describing the construction, functional characteristics of the instruments, methods of radioassay, and results for the period July 1, 1958, to July 1, 1960, has been submitted to the Defense Atomic Support Agency (DASA).

The 4 pi liquid scintillation counter employed by the Walter Reed Army Institute of Research is essentially a horizontal well counter and is

similar in design to that used at the Los Almos Scientific Laboratory.

The horizontal detector tank which surrounds the detector well (except at the ends) is 6 feet long, has an inner diameter of 32 inches, and can accommodate approximately 144 gallons of scintillation solution 4 grams per liter p-terphenyl plus 0.1 gram per liter POPOP (1,4-bis-[2-(5-phenyloxazolyl)]-benzene) in reagent grade toluene. The loading trough is a horizontal stainless-steel half-cylinder approximately 8 feet long with a radius of about 10 inches. A cylindrical shield (class B armor) surrounds the detector, providing 5½ inches of shielding.

Mounted radially through the outer wall and looking into the detector tank are six rows of five-inch photomultiplier tubes with five tubes in each row. These thirty 5-inch photomultiplier tubes provide an approximate 5.8 percent photocathode coverage of the area presented by the scintillation solution and are wired in 2 banks of 15 tubes each.

Two coincidence units are used. Channel I accepts pulses which represent photon energies of 0.3 to 0.8 Mev, and channel II, 0.9 to 2.0 Mev.

The procedures used to obtain counting efficiencies for $Cs^{137}$ and $K^{40}$ have been (1) the assembly of diffuse homogeneous sources of varying mass from 2.5-liter plastic bottles containing small quantities of the radioelement under study; (2) the use of a plastic manikin (Remcal, Alderson Research Laboratories); and (3) the determination of the counting efficiency for $K^{42}$ in the normal human subject at some time after equilibrium distribution.

The Whole Body Counting Facility of the U.S. Army Medical Research Unit in Landstuhl, Germany, has been assaying people since June 1959. This vertical, 2 pi, "walk-in" counter was originally designed for exhibit at the Second Geneva Conference on the Peaceful Uses of Atomic Energy. Subsequently, it was dismantled and reassembled at Landstuhl.

The Geneva counter [1] is far more simply constructed than its predecessor, the Los Alamos counter (for example, in the Geneva counter, the subject merely walks into the counting chamber). The counting "well" in which the subject stands is one-half of an 18-inch-diameter cylinder. The counter accommodates 280 liters of scintillation solution (terphenyl and POPOP in triethylbenzene), is equipped with 10 tons of lead shielding, and uses six 16-inch photomultiplier tubes which cover 13 percent of the wall area.

The Landstuhl data are listed by month and are tabulated in the upper part of table 2. The Walter Reed data are listed by quarters and geographic area and in tables 2, 3, and 4.

Table 4 has been based on the following calculations:

1. An average for the third and fourth quarters of 1960 was calculated by weighting the average values of cesium 137 per gram of potassium with the number of subjects in each quarter respectively. These values were extracted from tables 1 and 2.

2. The weighted average was multiplied by the average total quantity of potassium in the human body, 150 grams,[2] thus yielding the total cesium 137 content of a "standard man".

3. A "percent MPC" was calculated by comparing the total cesium 137 content of this "standard man" to one-tenth the maximum permissible burden in the human body for cesium 137;[3] i.e.,

TABLE 2.—TABULATED RESULTS FROM BOTH FACILITIES

| Date (inclusive when applicable) | Subjects residing in— | Number of subjects | μμc $Cs^{137}$/gm K (average) |
|---|---|---|---|
| U.S. Army Medical Research Unit: | | | |
| July 1960 | West Germany | 393 | 62 |
| August 1960 | do | 277 | 65 |
| September 1960 | do | 312 | 71 |
| October 1960 | do | 410 | 62 |
| November 1960 | do | 174 | 53 |
| Walter Reed Army Institute of Research: | | | |
| July 1958–June 1959 | United States | 906 | 69 |
| July 1959–June 1960 | do | 744 | 62 |
| July–September 1960 | do | 147 | 46 |
| October–December 1960 | do | 164 | 46 |

TABLE 3.—ASSAYS PERFORMED AT THE WALTER REED ARMY INSTITUTE OF RESEARCH, WASHINGTON, D.C.

| Geographic area | 3d quarter 1960 | | 4th quarter 1960 | |
|---|---|---|---|---|
| | Number of subjects | μμc $Cs^{137}$/gm K (average) | Number of subjects | μμc $Cs^{137}$/gm K (average) |
| Africa | 1 | 65 | | |
| Asia | 1 | 32 | 1 | 33 |
| Canada | | | 1 | 55 |
| Caribbean | | | 2 | 54 |
| Central America | 1 | 58 | 2 | 59 |
| Europe | 36 | 66 | 40 | 65 |
| Far East | 27 | 44 | 38 | 42 |
| Greenland-Iceland | 1 | 45 | | |
| Near East | 1 | 33 | 2 | 62 |
| Pacific islands | | | 5 | 43 |
| United States | 147 | 46 | 164 | 46 |

[1] Anderson, E. C., Hays, F. N., Hiebert, R. D., "Walk-in Human Counter," *Nucleonics, 16:* 8, p. 106, August 1958.

[2] Shohl, A. T., "Mineral Metabolism," Reinhold Publishing Co., New York, 1939.

[3] NBS HB-69, "Maximum Permissible Body Burdens and Permissible Concentrations of Radionuclides in Air and Water for Occupational exposure," June 1959.

it was compared to a value representing the maximum body burden for a member of the general population.

Future reports from both facilities will be presented quarterly in *Radiological Health Data.*

TABLE 4.—ASSAYS OF INDIVIDUALS RESIDING WITHIN THE UNITED STATES

*Performed at Walter Reed Army Institute of Research, Washington, D.C.*

| State | 3d quarter 1960 | | 4th quarter 1960 | |
|---|---|---|---|---|
| | Number of subjects | μμc $Cs^{137}$/gm K (average) | Number of subjects | μμc $Cs^{137}$/gm K (average) |
| Alabama | 2 | 35 | 3 | 56 |
| Alaska | 2 | 36 | 4 | 49 |
| Arizona | | | 1 | 50 |
| California | 6 | 35 | 8 | 31 |
| Colorado | 3 | 47 | | |
| Connecticut | 1 | 43 | 2 | 40 |
| Delaware | 1 | 36 | | |
| District of Columbia | 48 | 46 | 34 | 55 |
| Florida | 1 | 64 | 2 | 28 |
| Georgia | 2 | 52 | 2 | 44 |
| Hawaii | 5 | 38 | 1 | 43 |
| Idaho | | | 1 | 43 |
| Illinois | 2 | 45 | 9 | 30 |
| Indiana | 1 | 59 | 1 | 54 |
| Kansas | 3 | 40 | 1 | 42 |
| Kentucky | 1 | 59 | 6 | 39 |
| Louisiana | 3 | 36 | 2 | 53 |
| Maryland | 8 | 54 | 4 | 30 |
| Massachusetts | 1 | 83 | 8 | 66 |
| Michigan | 4 | 51 | 4 | 54 |
| Missouri | | | 3 | 26 |
| Nevada | | | 1 | 37 |
| New Jersey | 2 | 70 | 5 | 59 |
| New Mexico | | | 1 | 14 |
| New York | 10 | 51 | 17 | 53 |
| North Carolina | 1 | 61 | 6 | 53 |
| North Dakota | 1 | 47 | 1 | 56 |
| Ohio | 6 | 42 | 8 | 40 |
| Oklahoma | 1 | 54 | | |
| Oregon | 2 | 47 | | |
| Pennsylvania | 4 | 51 | 7 | 38 |
| Rhode Island | | | 1 | 53 |
| South Carolina | 1 | 20 | 2 | 43 |
| South Dakota | 1 | 47 | | |
| Tennessee | 1 | 35 | 1 | 64 |
| Texas | 11 | 34 | 10 | 32 |
| Utah | 1 | 48 | | |
| Virginia | 7 | 53 | 2 | 56 |
| Washington | 1 | 24 | 3 | 30 |
| West Virginia | 1 | 50 | 1 | 55 |
| Wisconsin | 2 | 46 | 2 | 51 |

TABLE 5.—PARTIAL SUMMARY OF TABLES 2 AND 3

| Country | 3d quarter | | 4th quarter | | Weighted average | Percent MPC |
|---|---|---|---|---|---|---|
| | Number of subjects | μμc $Cs^{137}$/gm K (average) | Number of subjects | μμc $Cs^{137}$/gm K (average) | | |
| Africa | 1 | 65 | | | 65 | 0.33 |
| Asia | 1 | 32 | 1 | 33 | 33 | .17 |
| Canada | | | 1 | 55 | 55 | .28 |
| Caribbean | | | 2 | 54 | 54 | .27 |
| Central America | 1 | 58 | 2 | 59 | 59 | .30 |
| Europe | 36 | 66 | 40 | 65 | 66 | .33 |
| Far East | 27 | 44 | 38 | 42 | 43 | .22 |
| Greenland-Iceland | 1 | 45 | | | 45 | .23 |
| Near East | 1 | 33 | 2 | 62 | 52 | .26 |
| Pacific islands | | | 5 | 43 | 43 | .22 |
| West Germany | 982 | 64 | 584 | [1] 59 | 62 | .31 |
| United States | 147 | 46 | 164 | 46 | 46 | .23 |

[1] Values represent determinations for October through November 1960.

## Body Burden of Radioisotopes in People Residing in the San Juan Basin

*Division of Radiological Health, Public Health Service*

A study of body burdens of radioisotopes in the population of the San Juan Basin area has been initiated by the Public Health Service at the request of the State health officers of Colorado and New Mexico. The study seeks answers to the following general questions:

1. Is the body burden a reliable and true index to clinical states that may be encountered?

2. Are safety factors which have been introduced in the radiation exposure guides realistic?

Specific objectives which will serve as a basis for answering these questions are:

1. Determination of body burden in a population which has resided for 10 years in an area served by a water supply periodically analyzed for radioactivity. This includes determining the body burden existing at the time of an initial examination, and the relative buildup in relation to concurrent amounts of radionuclides ingested in the normal diet and in excreta.

2. Devising of practical methods for determining the buildup of the radium body burden in a population, particularly the children of a study area.

The San Juan Basin population was chosen for this special study because of its exposure to radioactivity from drinking water containing radium in amounts higher than those found in most areas in the United States.

In order to relate measurements of concentrations of radium and strontium in food and water to health hazards, it is essential to know the actual physical dose absorbed by persons ingesting the contaminated food and water. Theoretical calculations of the physical dose based on measured concentrations in food and water are not sufficiently reliable to warrant their exclusive use. Thus, in addition to measuring intake and concentrations in food and water, an attempt will be made to measure the total amount of radionuclides present in the bodies of persons living in this area. In this fashion it is hoped that body burdens can be related to the basic standard of physical dose and that theoretical calculations can be compared to actual experimental measurements.

In order to determine a population displaying appropriate characteristics, a special census was taken by the 1960 census enumerators under contract with the New Mexico Department of Public Health. The purpose was to determine families meeting the over 10 years' residence criterion. It is proposed to select at random 100 families (about 400 persons) from those meeting the residence criterion. For this sample a complete analysis of intake of radioactive substances via food and water will be carried out. Concurrently, the excretion rates of radium and strontium will be measured in feces, urine, and breath. In addition, human and animal bone samples will be collected for analysis.

A study also will be made of the buildup of body burdens of children, immigrants, and newborns in the area.

Environmental assessment, in order to describe the complete radiological health situation in the area of study, will include collection and analyses of samples of potable and raw water, soil, vegetation, and human food supplies. Information from this source will be correlated with data obtained from a total assessment of radiation exposure of all origins: diagnostic, therapeutic, external environmental, and occupational.

Vital statistics of the area will be studied to discern any unusual patterns of morbidity or mortality which may exist. Following an analysis of these data, a complete prospective epidemiological and clinical investigation of those families in the area meeting the requirement of long-term residency may be undertaken.

It is estimated that this study will require a minimum of 5 years, with a 15-year span being considered desirable to develop valid results.

This study is being conducted as a cooperative venture of the Public Health Service and the New Mexico Department of Public Health. An on-site limited laboratory facility has been staffed and equipped in Farmington, N. Mex., for the purpose of processing the biological samples obtained. It is planned that detailed radioactivity analyses will be conducted by Public Health Service laboratories at other locations. Radon breath analysis equipment has been ordered and is expected to be operational on-site by July 1961. Methodology for collecting and processing samples has been devised and is undergoing testing. A pilot study of a few of the selected 100 families has begun. As the data become available, they will be published in future issues of *Radiological Health Data*.

## Strontium 90 Content of Human Bone and Teeth

*Health and Safety Laboratory, U.S. Atomic Energy Commission*

The Health and Safety Laboratory has been obtaining samples of bone from children who died in New York City since 1957. These samples are taken only from the bodies of children whose nutrition and calcium metabolism can be presumed to have been normal prior to death.

Late in 1959 an effort was made to obtain teeth as well as bone samples from the same cadaver to see if a relation could be established between the $Sr^{90}/Ca$ ratio of primary teeth and the skeletal strontium 90 burden.

The results obtained thus far in this continuing program are presented in table 6.[4]

[4] Data from *Quarterly Summary Report*, HASL-105, Jan. 9, 1961.

TABLE 6.—STRONTIUM 90 IN HUMAN BONE AND TEETH

| Date of death | Age (years) | Sex | Type samples | Number specimens | Calcium | Strontium 90 | |
|---|---|---|---|---|---|---|---|
| | | | | | mg/gm original material | μμc/gm original material | μμc/gm Ca |
| 1957: | | | | | | | |
| September | 6½ | F | Bone | | | | 1.30 |
| September | 6¾ | M | Bone | | | | 88 |
| 1958: | | | | | | | |
| September | 5 | M | Sternum, rib | | | | |
| | | | Vertebrae, skull | | | | .83 |
| December | 5 | F | Bone | | | | 1.61 |
| September | 7 | M | Bone | | | | 1.10 |
| June | 8 | M | Vertebrae | | | | 1.27 |
| September | 10 | F | Rib, vertebrae | | | | 1.02 |
| September | 11 | M | Sternum, rib | | | | |
| | | | Vertebrae, skull | | | | .69 |
| 1959: | | | | | | | |
| January | 3 | M | Spine | | | | 1.80 |
| January | 3 | M | Rib | | | | 1.75 |
| September | 4 | M | Teeth | 6 | 242 | 0.51 | 2.12 |
| November | 4½ | F | Teeth | 5 | 264 | .76 | 2.86 |
| September | 7 | M | Teeth | 8 | 253 | .16 | .64 |
| September | 8 | M | Teeth | 6 | 247 | .10 | .40 |
| September | 10 | M | Teeth | 8 | 252 | .07 | .27 |
| 1960: | | | | | | | |
| January | 2½ | F | Rib | | 48 | .14 | 2.83 |
| | | | Vertebrae | | 37 | .11 | 2.93 |
| | | | Teeth | | 198 | .40 | 2.02 |
| March | 4 | F | Femur | | 184 | .60 | 3.30 |
| | | | Rib | | 96 | .30 | 3.16 |
| | | | Teeth | 7 | 284 | .54 | 1.91 |

# ENVIRONMENTAL LEVELS OF RADIOACTIVITY AT ATOMIC ENERGY COMMISSION INSTALLATIONS

The U.S. Atomic Energy Commission is providing data on environmental levels of radioactivity in the vicinity of major Commission installations to the Public Health Service on a quarterly basis. The data are from routine monitoring programs where operations are of such a nature that plant perimeter surveys are required.

*Radiological Health Data*, Volume I, Nos. 8 and 9, and Volume II, Nos. 1, 2, and 3, contain summaries for 16 installations. Summaries follow for Argonne National Laboratory, covering the second quarter of 1960, and the Feed Materials Production Center, covering 1959 and the first two quarters of 1960.

## Argonne National Laboratory

*University of Chicago, Lemont, Ill., Issued December 20, 1960*

Environmental levels of radioactivity at Argonne National Laboratory (ANL) for 1959 and first quarter 1960 were reported in *Radiological Health Data*, Volume I, No. 9. The following report presents a summary of the data for the second quarter of 1960.

The radioactivity in the environment is determined by measuring concentrations of radioactivity in naturally occurring materials collected on the ANL site and to a distance of 100 miles from the site. Since air and water are the most probable media for disseminating radioactivity, the environmental monitoring program at ANL has concentrated on these materials. The air- and water-sampling locations discussed in this report are shown in figures 7 and 8.

Figure 7 is a map of the ANL site which has been divided into 1,000-foot squares by a series of grid lines. Sampling points on the site are identified by specifying the square in which they are located. For example, the Sawmill Creek sampling locations are in squares 13L and 7M. Sampling locations off the site (fig. 8) are identified by their geographical location.

Samples are first analyzed for their total alpha and total beta radioactivity. These analyses provide a rapid means of assessing the general radioactive level of the samples and indicate whether the samples contain normal or above-normal amounts of radioactivity. Some of the samples are then analyzed for specific isotopes that are likely to be responsible for the alpha and beta activities observed.

### *Radioactivity in Surface Water*

ANL waste water is analyzed for radioactive content prior to discharge into Sawmill Creek, a small stream that runs through the ANL grounds and empties into the Des Plaines River about 500 yards downstream from the waste water outfall. Sawmill Creek was sampled upstream from the ANL site and downstream from the waste water outfall to determine if any radioactivity was added to the creek by ANL waste water. The uranium and total alpha activity found in

FIGURE 7.—SAMPLING LOCATIONS, ARGONNE NATIONAL LABORATORY

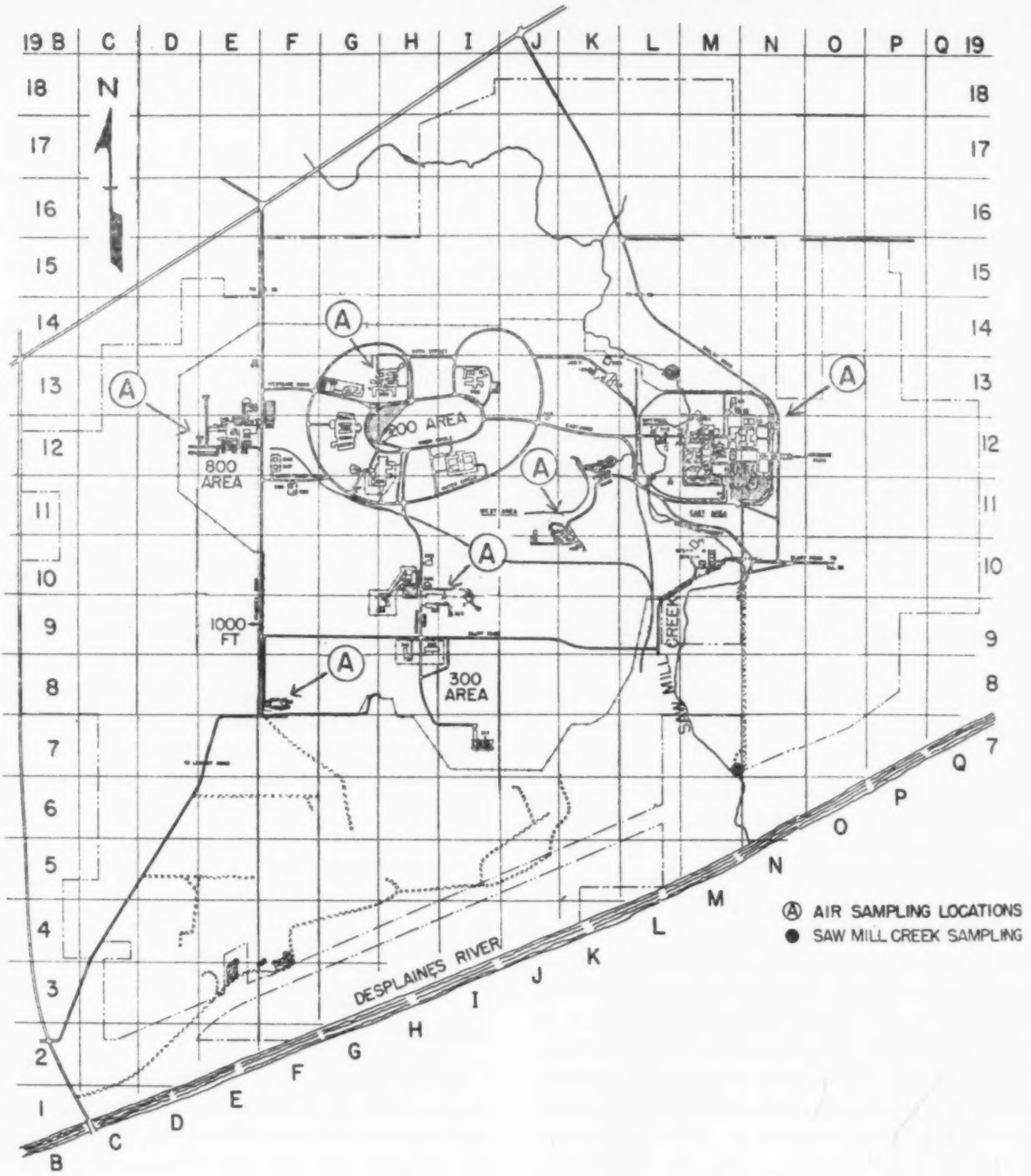
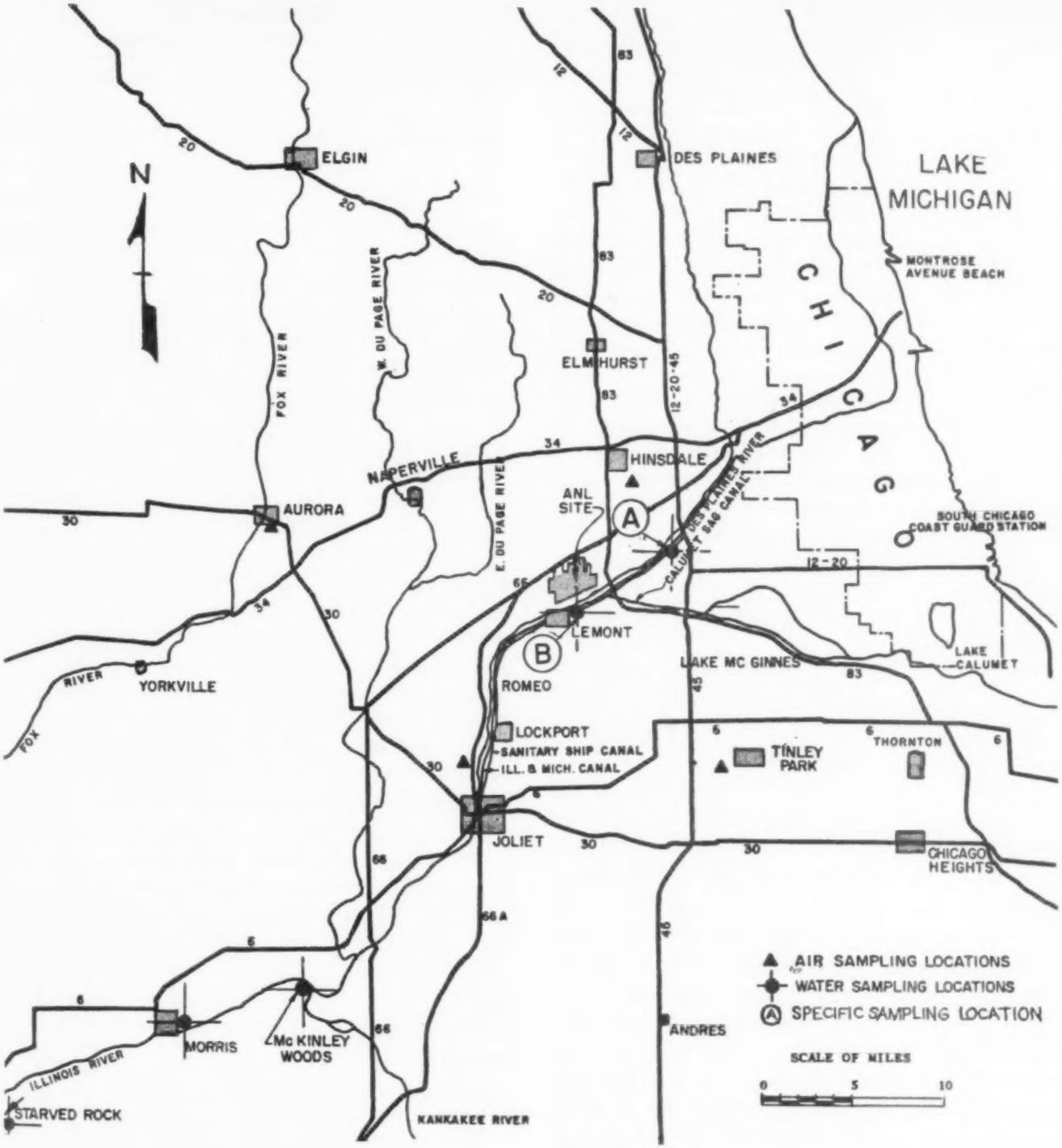

19 B C D E F G H I J K L M N O P Q 19
18 17 16 15 14 13 12 11 10 9 8 7 6 5 4 3 2 1
N
A
800 AREA
200 AREA
300 AREA
1000 FT
SAW MILL CREEK
DESPLAINES RIVER
B C D E F G H I J K L M N O P Q
A AIR SAMPLING LOCATIONS
SAW MILL CREEK SAMPLING

FIGURE 8.—OFF-SITE SAMPLING LOCATIONS, ARGONNE NATIONAL LABORATORY



Sawmill Creek during the second quarter of 1960 are given in the following table.

TABLE 7.—URANIUM AND TOTAL ALPHA ACTIVITY IN SAWMILL CREEK WATER

[Average concentration in μμc/liter]

| Period | Location (see fig. 1) | Uranium | | Total alpha | |
|---|---|---|---|---|---|
| | | No. of samples | Activity | No. of samples | Activity |
| April | 13L | 4 | 1.1 | 4 | 2.3 |
| | 7M | 7 | 14.5 | 13 | 16.1 |
| May | 13L | 4 | 1.4 | 4 | 1.5 |
| | 7M | 8 | 32.1 | 12 | 22.3 |
| June | 13L | 5 | 1.4 | 5 | 2.1 |
| | 7M | 7 | 63.9 | 13 | 35.3 |
| 2d quarter | 13L | 13 | 1.3 | 13 | 2.0 |
| | 7M | 22 | 36.8 | 38 | 24.6 |

Upstream from the ANL site the alpha activity in the creek was attributed to naturally occurring radioactive isotopes. The additional alpha activity below the waste-water discharge was evidently due to radioactive materials added to the stream by ANL waste water. Comparison of the total alpha activity with the uranium content shows that the alpha activity added to the stream in ANL waste water was almost entirely due to uranium.

The average uranium concentration added to the stream by Argonne waste water in those samples of below-outfall water that were analyzed for uranium was approximately 36μμc per liter, or 0.18 percent of the MPC.[1] Since some of the outfall samples that contained below-average amounts of total alpha activity were not analyzed for uranium, the average uranium concentration was higher than the average alpha activity of all the samples. If the average total alpha activity in all below-outfall water samples is taken as the average uranium concentration (and this is essentially correct), the average uranium contribution by ANL was about 24μμc per liter, or 0.12 percent of the MPC. During 1959 and the first quarter of 1960, the uranium added by ANL to Sawmill Creek amounted to 0.1 and 0.63 percent of the MPC, respectively. Small amounts of plutonium and thorium contributed by ANL waste water were also found in Sawmill Creek below the waste-water outfall. The alpha activities due to these elements are summarized in the table below.

[1] The values for MPC are one-tenth of the MPC allowed for continuous occupational exposure as given in "Handbook 69," National Bureau of Standards, issued June 5, 1959.

TABLE 8.—PLUTONIUM AND THORIUM IN SAWMILL CREEK WATER

*Second Quarter 1960*

[Average concentrations in μμc/liter]

| Location (see fig. 1) | Number samples | Plutonium | Thorium |
|---|---|---|---|
| Above site (13L) | 8 | <0.05 | 0.1 |
| Below outfall (7M) | 12 | .1 | .3 |

The averages were calculated assuming a concentration of 0.025 μμc per liter (one-half of the minimum detectable amount) in those samples containing less than 0.05 μμc per liter.

Since plutonium was not detected in above-site water, the plutonium found below the outfall was added in ANL waste water. At the latter location the average plutonium concentration, 0.1 μμc per liter, amounted to 0.002 percent of the MPC. Thorium was detected in some of the samples from both locations. Sawmill Creek dilutes the waste water by approximately one-half. The average thorium concentration contributed to the creek by waste water can be approximated by subtracting one-half of the creek concentration above ANL from the average concentration below the outfall. This value, 0.25 μμc per liter, is 0.013 percent of the MPC. Radium, another important alpha emitter, was present only in naturally occurring concentrations in the creek.

The results of total beta activity measurements made on Sawmill Creek water during the second quarter of 1960 are tabulated below.

TABLE 9.—TOTAL BETA ACTIVITY IN SAWMILL CREEK WATER

[Average concentration in μμc/liter]

| Month | Location (see fig. 1) | Number samples | Beta activity |
|---|---|---|---|
| April | 13L | 4 | 6.0 |
| | 7M | 13 | 28.7 |
| May | 13L | 4 | 4.3 |
| | 7M | 22 | 26.8 |
| June | 13L | 5 | 4.4 |
| | 7M | 13 | 32.8 |
| 2d quarter | 13L | 13 | 4.9 |
| | 7M | 38 | 29.4 |

The average total beta activity added to the creek by ANL waste water was approximately 29 μμc per liter. About 17 μμc per liter (0.09 percent of the MPC) was due to thorium 234 and protoactinium 234, radioactive decay daughters of uranium. Other beta-emitting isotopes found in the creek as a result of their presence in ANL waste water were cobalt 58, strontium 90, and cesium 137. The concentrations of these isotopes are summarized in the following table.

TABLE 10.—COBALT 58, STRONTIUM 90, AND CESIUM 137 IN SAWMILL CREEK WATER

*Second Quarter 1960*

[Average concentrations in μμc/liter]

| Isotope | Location (see fig. 1) | Number samples | Activity |
|---|---|---|---|
| Cobalt 58 | 13L | 4 | [1] ND |
| | 7M | 8 | 5 |
| Strontium 90 | 13L | 6 | 1.1 |
| | 7M | 17 | 1.6 |
| Cesium 137 | 13L | 6 | .7 |
| | 7M | 17 | 2.3 |

[1] Not detectable by methods used.

The absence of cobalt 58 in above-site water indicates that all the cobalt 58 below the outfall was added by ANL waste water. The strontium 90 and cesium 137 activities in the creek water above ANL resulted from fission product fallout. Since this water dilutes waste water by approximately one-half, the average concentrations of strontium 90 and cesium 137 added to the creek below the outfall were only about 1.0 and 2.0 μμc per liter, respectively. However, the total concentrations below the outfall were used to calculate the percentage of the MPC, since all manmade activity, regardless of source, must be used when evaluating the radiological hazard.

Analyses for other fission products were also made. These were either absent, or present so infrequently and in such small concentrations that they contributed negligible amounts of beta activity to the creek.

Since Sawmill Creek empties into the Des Plaines River, which in turn flows into the Illinois River, the radioactivity in the latter two streams is important. The Des Plaines River was sampled above and below the mouth of Sawmill Creek to determine if the radioactivity in Sawmill Creek had any effect on the activity in the river. The total activities and uranium concentrations found in the Des Plaines River are given in the following table.

TABLE 11.—TOTAL ALPHA, BETA, AND URANIUM ACTIVITIES IN DES PLAINES RIVER WATER

*Second Quarter 1960*

[Average concentrations in μμc/liter]

| Month | Location (see fig. 8) | Number samples | Alpha | Beta | Uranium |
|---|---|---|---|---|---|
| April | A | 2 | 1.6 | 5.1 | 0.9 |
| | B | 2 | 1.6 | 6.6 | .9 |
| May | A | 3 | 2.4 | 7.7 | 1.5 |
| | B | 4 | 2.1 | 7.1 | 1.4 |
| June | A | 5 | 2.7 | 7.3 | 1.6 |
| | B | 5 | 2.6 | 7.8 | 1.6 |
| 2d quarter | A | 10 | 2.4 | 7.0 | 1.4 |
| | B | 11 | 2.2 | 7.3 | 1.4 |

The sample collected on April 28 contained 1.4 μμc of uranium and less than 0.05 μμc of plutonium and thorium per liter. The sample collected at McKinley Woods State Park contained about 0.5 μμc of strontium 90 and less than 0.05 μμc of plutonium and thorium per liter. All of the results obtained for the Illinois River were in the range normally found for surface water in the area.

The alpha, beta, and uranium activities were uniformly low and in the range normally found in the Des Plaines River when fallout activity is low. There was no important or significant difference in activity between samples collected from the two locations. The activities were also similar to those found in other streams in the Chicago area during this period. The latter samples contained from 1 to 3 μμc of alpha activity per liter, 4 to 9 μμc of beta activity per liter and from 1 to to 2 μμc of uranium per liter. About one-third of the Des Plaines River samples were also analyzed for plutonium, thorium, cesium 137, and strontium 90. At both locations the strontium 90 and cesium 137 concentrations varied from 1 to less than 0.5 μμc per liter, and the plutonium and thorium concentrations were all less than 0.05 μμc per liter. Again, no difference was found between samples from the two locations. Apparently as a result of dilution of Sawmill Creek water by the much larger volume of water in the Des Plaines River, the radioactivity in Sawmill Creek had no detectable effect on the radioactivity in the Des Plaines River.

The Illinois River was sampled in April and May with the following results.

TABLE 12.—TOTAL ALPHA AND BETA ACTIVITY IN ILLINOIS RIVER

*Second Quarter 1960*

[Average concentrations in μμc/liter

| Location | Date | Alpha | Beta |
|---|---|---|---|
| Morris | Apr. 28 | 1.8 | 4.9 |
| Do | May 26 | 1.4 | 4.7 |
| McKinley Woods State Park | May 26 | 2.7 | 8.3 |
| Starved Rock State Park | May 28 | 1.4 | 4.2 |

## *Radioactivity in Air*

Air was sampled by drawing it through filter paper at a known rate and analyzed by measuring the radioactivity in the particles collected on the paper. Samples were collected continuously at five locations at the ANL site and at four locations

near the site. The latter locations were near Aurora, Hinsdale, Joliet, and Tinley Park. The filter papers were changed at weekly intervals. Monthly averages of the results are tabulated below.

TABLE 13.—RADIOACTIVITY IN AIR FILTER SAMPLES

*Second Quarter 1960*

[Average concentrations in $\mu\mu c/m^3$]

| Month | Location | Number samples | Alpha | Beta |
|---|---|---|---|---|
| April | On site | 15 | 0.005 | 0.15 |
| | Off site | 8 | .004 | .14 |
| May | On site | 22 | .006 | .12 |
| | Off site | 12 | .005 | .12 |
| June | On site | 17 | .005 | .13 |
| | Off site | 16 | .005 | .14 |
| 2d quarter | On site | 54 | .005 | .13 |
| | Off site | 36 | .005 | .13 |

These results were obtained by measuring the samples 3 days after they were collected in order to avoid counting the natural radioactivity due to radon and thoron decay products. This activity, normally present in the air and in considerably larger amounts than the activities expected from fallout or from ANL, disappears within 3 days by radioactive decay.

The alpha and beta activities given in table 11 are due to a number of radioactive isotopes present in the air samples. The application of MPC's to such mixtures is somewhat different than in the case of a single isotope. Handbook 69 (p. 94) recommends a series of MPC's which become progressively larger as some of the more hazardous isotopes are eliminated from the mixture. For the samples collected near ANL, the applicable MPC is 100 $\mu\mu c$ per cubic meter. The total average air activity during the quarter, 0.135 $\mu\mu c$ per cubic meter, is then about 0.14 percent of the MPC. Within the sample collection and analytical error of 10 to 20 percent, the average alpha and beta activities were essentially the same on and off the ANL site. Individual samples collected at the same time from different locations may show differences somewhat greater than this error due to a variety of factors, including the amount of dust in the air at each location. Such differences become unimportant when comparisons are made between the averages of a large number of samples. If activity used at ANL were discharged to the atmosphere, higher activities would be expected on the site. Since this was not the case, ANL did not add significantly to the airborne radioactivity of the environment. Additional evidence to support this conclusion is given in the table below.

TABLE 14.—RELATIVE CONCENTRATIONS OF CERIUM 144, RUTHENIUM 106, AND CESIUM 137 IN AIR FILTER SAMPLES

*Second Quarter 1960*

[*Average concentrations in cpm/1000m³*]

| Month | Cerium 144 | | Ruthenium 106 | | Cesium 137 | |
|---|---|---|---|---|---|---|
| | At ANL | Near ANL | At ANL | Near ANL | At ANL | Near ANL |
| April | 2.87 | 3.29 | 3.42 | 4.05 | 3.28 | 3.94 |
| May | 2.20 | 2.43 | 2.68 | 3.08 | 2.52 | 2.81 |
| June | 2.59 | 2.93 | 3.66 | 4.03 | 3.04 | 3.34 |

This table gives the relative concentrations of the principal gamma-ray emitting fission products present in all the air samples collected during the quarter. The results parallel the total beta activity (all three isotopes emit beta particles as well as gamma rays) in that they show a decrease in May relative to April and June. The concentrations of these fission products are in all cases 10 to 15 percent higher off the ANL site than on the site. This is within the sampling and analytical errors, but if the differences were due only to these errors, it would be unlikely for the results to be consistently higher off the site. The exact reasons for this discrepancy are not known at present, but the results are in agreement with the interpretation that these fission products did not originate at ANL, but came from outside and widespread sources, such as fallout from nuclear test detonations.

The total alpha activities were similar to those found earlier; the beta activities were about 20 times lower than those found from 1957 to 1959 and 35 percent higher than observed during the first quarter of 1960. The variations in beta activity were due to variations in the amount of fission product fallout. Except for two relatively small nuclear detonations in February 1960 (French), fission products from nuclear testing have not been added to the atmoshere since the end of 1958. Consequently, a sharp drop in airborne beta activity in 1960 relative to 1959 was expected. The small increase during the spring and early summer of 1960 over the winter months probably was due to meteorological conditions re-

sulting in increased fallout of fission products stored in the stratosphere from earlier testing. Since short-lived fission products were not present in the air samples collected during the second quarter of 1960, the increase was not due to the February detonations. Additional information on the air-sampling program and on the interpretation of results, together with the air activities since 1953, are given in the first report in this series.

## Feed Materials Production Center

*National Lead Co. of Ohio, Fernald, Ohio, Issued January 13, 1961*

Environmental levels of radioactivity at the Feed Material Production Center (FMPC) are reported for the first time in this issue. The following report summarizes the data for 1959 and the first and second quarters of 1960.

The FMPC is operated by the National Lead Co. of Ohio (NLO) for the Atomic Energy Commission (AEC). Feed material operations deal with the processing of high-grade uranium ores and ore concentrates to produce metallic uranium. The final product is used in the United States as a fuel for reactors.

During the many involved reactions and processes that lead to the reactor fuels, various liquid and airborne wastes are generated. Various in-plant methods are used to curtail their release into the environment surrounding the plant. Almost complete removal of the materials is accomplished by using dust collectors and waste treatment processes. Since it is impossible to obtain 100 percent removal, some of the material does reach the environs outside the plant. An environmental survey program consisting of water and air sampling of the the environs has been established. The results from the second-quarter sampling revealed that the control of material released to the environs at this site is well within the maximum permissible concentrations (MPC) as recommended by the National Committee on Radiation Protection and Measurements and as adopted by the State of Ohio.

### *Water Sampling*

Water samples are taken to determine the effect of the site's liquid wastes upon the Great Miami River, into which all of the plant's liquid effluents pass. The results of the monitoring of liquid effluents have been reported to the Ohio Department of Health on a monthly basis since 1954, and duplicate samples are often taken by a State engineer and an NLO industrial hygienist. In some cases, samples are exchanged in order that each group may evaluate the other's sampling procedure and analytical results.

The locations of all of the water sampling points are shown in figure 9. A continuous-type water sampler collects the plant effluent at the outfall (point B). Since it is difficult to have this type of sampler in an upstream (point A) and downstream location (point C), spot samples are taken at these points. The collected samples are analyzed for uranium, total radioactivity, chlorides, fluorides, and nitrates.

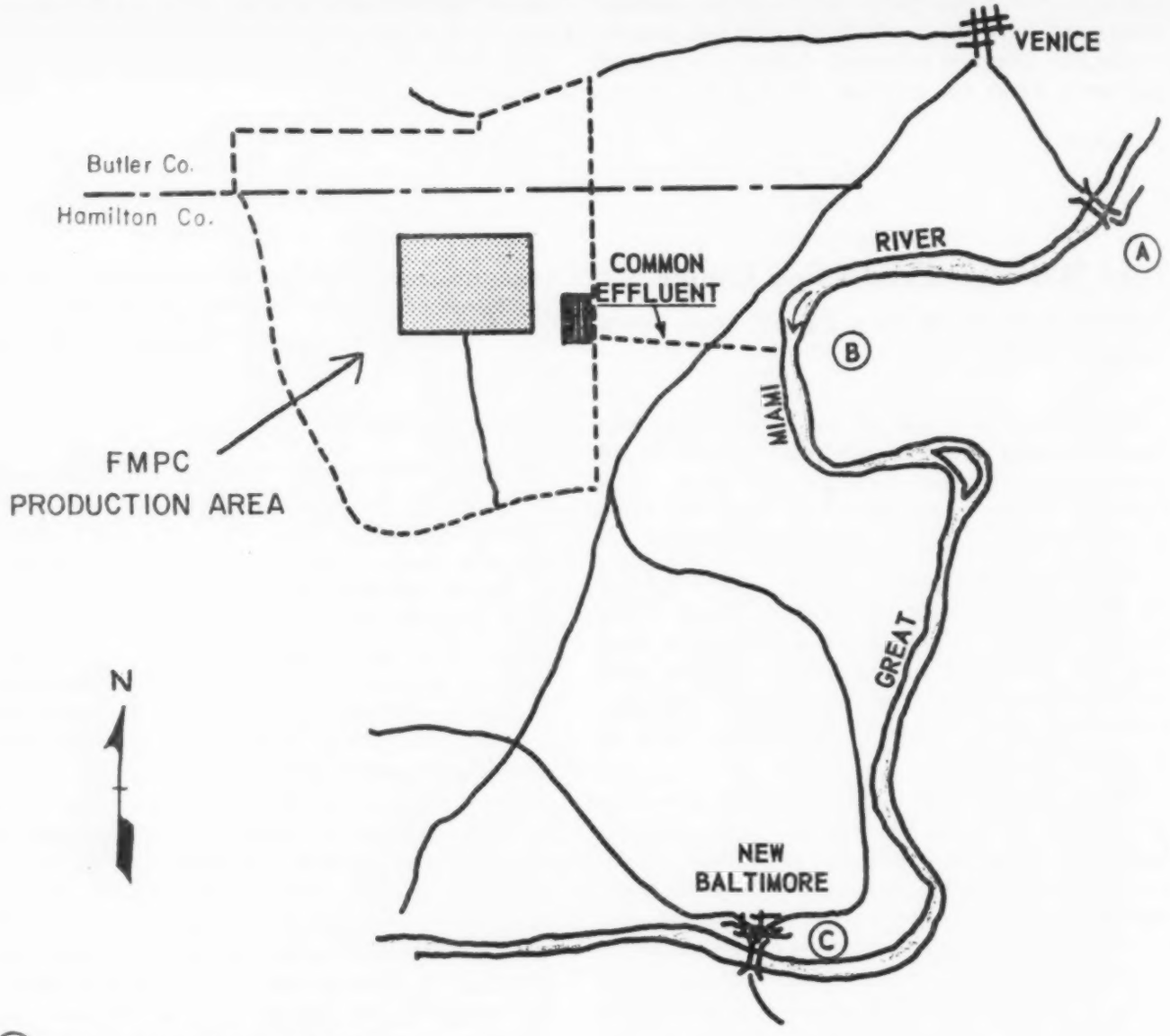
The results in table 15 indicate that the liquid wastes discharged by this plant during the second quarter were small in relation to the MPC's. Results C minus A (the difference in upstream and downstream concentrations) indicate that the FMPC effluent produced little or no change in the river's quality.

TABLE 15.—RADIOACTIVITY IN GREAT MIAMI RIVER WATER

[Average concentrations in μμc/liter]

| Location | Calendar year 1959 | | | 1st quarter 1960 | | | 2d quarter 1960 | | |
|---|---|---|---|---|---|---|---|---|---|
| | Number of samples | Uranium | Total activity | Number of samples | Uranium | Total activity | Number of samples | Uranium | Total activity |
| Upstream (A) | 33 | 4.0 | 50 | 12 | 6.7 | 31 | 15 | 12 | 70 |
| Outfall (B) | 365 | 1.0 | 5 | 91 | .4 | 2 | 91 | 6 | 9 |
| Downstream (C) | 33 | 4.7 | 50 | 12 | 9.0 | 38 | 15 | 20 | 90 |
| C−A | | .7 | 0 | | 2.3 | 7 | | 8 | 20 |

FIGURE 9.—WATER SAMPLING LOCATIONS, FERNALD FMPC AND SURROUNDINGS




(A) – Water Sampling Stations

### *Air Sampling*

Air samples and gumpapers from fallout stations are collected around the 1,000-acre plant site and at points as far away as 15 miles. The sampling of airborne particulate matter provides a good indication of the amount of material released into the atmosphere by the plant. The amount of particulates in the air is calculated by drawing a known quantity of air through a filter paper analyzing the paper for uranium and total activity. The air-sampling locations in the production area are shown in figure 10.

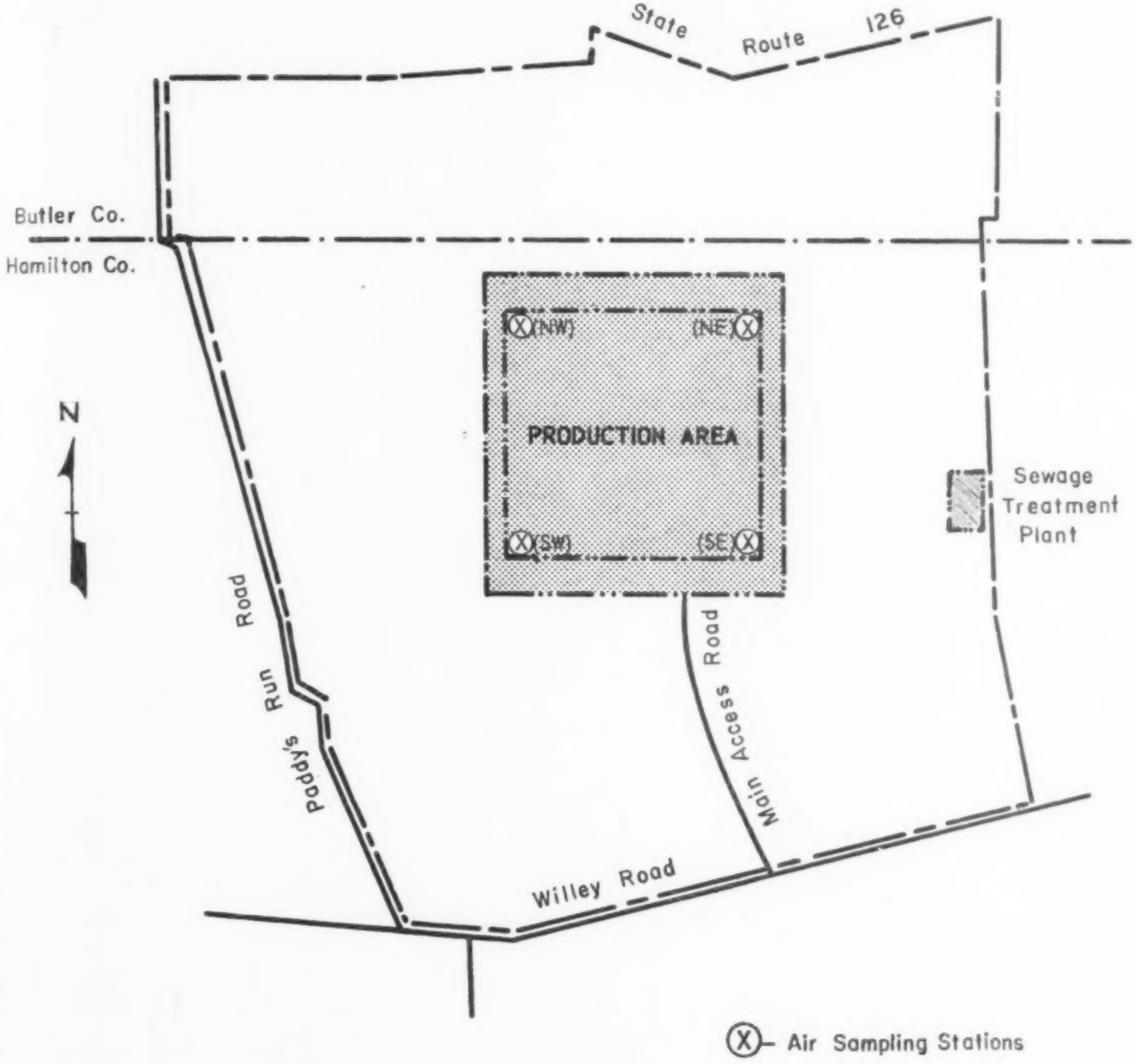
Due to construction work being carried out at the FMPC, it was not possible to conduct the routine air-sampling program during the first quarter. Only two stations were in operation during the second quarter. It should be pointed out that the two stations that were in operation were predominantly downwind, since the wind is usually from a southwesterly direction. The results of the sampling indicate that even within the project area owned and controlled by the AEC, the concentrations were always well within the maximum permissible concentrations.

TABLE 16.—RADIOACTIVITY IN AIR FILTER SAMPLES

[Average concentrations in $\mu\mu c/m^3$]

| Location | Calendar year 1959 | | | 1st quarter 1960 | 2d quarter 1960 | | |
|---|---|---|---|---|---|---|---|
| | Number samples | Uranium | Total activity | | Number samples | Uranium | Total activity |
| Southwest | 13 | 0.131 | 0.87 | No samples taken | No samples taken | | |
| Northwest | 8 | .108 | .84 | | 10 | 0.20 | 0.43 |
| Northeast | 19 | .115 | .78 | | 10 | .15 | .37 |
| Southeast | 18 | .060 | .60 | | No samples taken | | |
| Plant average | | .104 | .77 | | | .175 | .40 |

FIGURE 10.—AIR SAMPLING LOCATIONS, FERNALD FMPC AND SURROUNDINGS



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